201-15166

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April 6, 2004

Administrator Michael O. Leavitt
U.S. Environmental Protection Agency
PO BOX 1473
Merrifield, VA 22116

Attention: Chemical Right-to-Know HPV Consortium
Re: Benzenemethanethiol (CASN 100-53-8)

Dear Administrator Leavitt:

Chevron Phillips Chemical Company LP is pleased to submit the Benzenemethanethiol (CASN 100-53-8) Test Plan.

This submission is also being sent, via email, to the individuals listed below and opt.ncic@epa.gov; chem.rtk@epa.gov .

Sincerely,

Vicente Santa Cruz, Ph.D.

Enclosures:
Test Plan and IUCLID data sets on CASN 100-53-8 and CASN 108-98-5

Cc: R. Hefter, USEPA
O. Hernandez, USEPA

201-15166A

High Production Volume (HPV) Challenge Program

Benzenemethanethiol
CAS Number 100-53-8

Chevron Phillips Chemical Company LP
10001 Six Pines Drive
The Woodlands, Texas 77380

March 2004

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ABBREVIATIONS

BCF = predicted bioconcentration factor
Benzenemethanethiol = Benzyl Mercaptan
BZM = Benzyl Mercaptan
cm^3 = cubic centimeter
CPChem = Chevron Phillips Chemical Company LP
CSI-Closed System Intermediate
gd = gestation day
H_2S = hydrogen sulfide
hPa = hectopascal
HPV = High Production Volume
IUCLID = International Uniform Chemical Information Dataset
Koc = organic carbon partition coefficients
LC_{50} = lethal concentration (to 50% of animals dosed)
LD_{50} = lethal dose (to 50% of animals dosed)
LOAEL = lowest observed adverse effect level
mg/kg = milligram per kilogram
mg/L = milligrams per liter
mmHg = millimeter mercury
NaSH = sodium hydrosulfide
NOAEL = no observed adverse effect level
OECD = Organisation for Economic Cooperation and Development
PHM = Phenyl Mercaptan
QSAR = Quantitative Structure Activity Relationship
RACB = Reproductive Assessment by Continuous Breeding
SIDS = Screening Information Data Set
USEPA = United States Environmental Protection Agency
USFDA = United States Food and Drug Administration

I. EXECUTIVE SUMMARY

Chevron Phillips Chemical Company LP (CPChem) is committed to fulfilling the High Production Volume (HPV) commitments it made under the United States Environmental Protection Agency (USEPA) HPV Challenge Program on February 14, 2001. As part of this commitment, CPChem has volunteered to assess the health and environmental hazards, including selected physicochemical characteristics of Benzenemethanethiol (CASN 100-53-8), commonly known as and referred to hereafter as Benzyl Mercaptan (BZM). BZM is a member of the broader family of organomercaptans, which are characterized by their very strong malodor and low odor threshold. CPChem currently manufactures BZM for use as a raw material in the production of agricultural pesticide ingredients.

CPChem has identified data from company proprietary files, peer-reviewed literature, and/or calculated endpoints using widely accepted computer modeling programs. In fulfillment with USEPA guidance for use of read-across data (USEPA, 1999b), CPChem proposes the use of surrogate data from Phenyl Mercaptan (CASN 108-98-5) (PHM), a close structural analogue to BZM, to fill Screening Information Data Set (SIDS) endpoint data gaps and provide additional support in our understanding of health and environmental hazards for BZM. Both BZM and PHM have a relatively narrow range of physicochemical parameters and are composed of similar functional groups. Thus, these two substances are expected to demonstrate similar environmental fate and toxicological profiles.

Physicochemical endpoints for BZM are fulfilled by using existing measured data or data calculated by the EPIWIN© computer model. No additional testing is proposed for this program.

An estimation from a Level III fugacity model predicts that BZM and PHM will likely partition to soil and water. Ready biodegradation testing showed that BZM is not readily biodegradable. The predicted bioconcentration factors and organic carbon partition coefficients for BZM and PHM suggest similar fate profiles in the environment and no bioaccumulation hazard for either BZM or PHM. A review of the existing data for BZM and PHM shows that sufficient data are available to characterize the environmental fate of BZM, with the exception of the Hydrolysis SIDS endpoint. Additional testing for the Hydrolysis SIDS endpoint is therefore proposed for this program.

A review of the existing data for BZM and PHM shows that insufficient data are available to characterize aquatic toxicity. Additional testing for the Acute Toxicity to Fish and Aquatic Plants (Algae) endpoint is proposed for this program.

A limited amount of existing mammalian toxicity information on BZM and PHM demonstrates that PHM is a conservative read across benchmark, with slightly higher toxicity than BZM. Acute toxicity studies show that BZM is of low acute toxicity by oral, inhalation, dermal, and intraperitoneal routes. BZM has not been tested for reproductive toxicity; reproductive toxicity data are available for PHM. Due to its close

structural similarity to PHM, as well as the demonstrated higher level of acute toxicity of PHM, it would be expected that BZM would be of a similar order of magnitude as PHM, if not of lower reproductive toxicity. Repeated dose toxicity testing has not been performed on BZM or PHM; therefore, repeated dose toxicity testing is proposed. Likewise, no *in vitro* chromosomal aberration studies were identified for either BZM or PHM. As a result, testing is proposed to meet the chromosomal aberration requirements. BZM has not been tested for developmental toxicity; however data is available for PHM. Due to its close structural similarity to PHM, as well as the demonstrated higher level of acute toxicity of PHM, it would be expected that BZM would be of a similar order of magnitude as PHM, if not of lower developmental toxicity.

Nearly all HPV endpoints have been satisfied for BZM. The close structural surrogate PHM serves as a read-across for some endpoints (as described below). PHM surrogate data are available for several HPV endpoints. Table 1 summarizes the available data for BZM and PHM.

Table 1. Matrix of Available and Adequate Data on BZM and PHM

Test	BZM Y/N (Klimish Score)	PHM Y/N (Klimish Score)	Testing Planned? Y/N
Physical and Chemical Data			
Melting Point	Y (2)	Y (2)	N
Boiling Point	Y (2)	Y (2)	N
Vapor Pressure	Y (2)	Y (2)	N
Partition Coefficient	Y (2)	Y (2)	N
Water Solubility	Y (2)	Y (2)	N
Environmental Fate and Pathways			
Photodegradation	Y (2)	Y (2)	N
Stability in Water (Hydrolysis)	N	N	Y
Transport/Distribution	Y (2)	Y (2)	N
Biodegradation	Y (2)	N	N
Ecotoxicity			
Acute/Prolonged Toxicity to Fish	N	N	Y
Acute Toxicity to Aquatic Invertebrates (*Daphnia*)	Y (1)	N	N
Acute Toxicity to Aquatic Plants (Algae)	N	N	Y
Toxicity			
Acute Toxicity (Oral)	Y (2)	Y (2)	N
Acute Toxicity (Inhalation)	Y (2)	Y (2)	N
Acute Toxicity (Dermal)	Y (1)	Y (2)	N
Repeated Dose	N	N	Y
GeneticToxicity *in vitro* – Gene Mutation	Y (2)	N	N
Genetic Toxicity – Chromosomal Aberration	N	N	Y
Reproductive Toxicity	N	Y (1)	N
Developmental Toxicity	N	Y (1)	N

Note: *The data used to characterize the OECD SIDS endpoints for substances in this Test Plan were identified either in company proprietary files, peer-reviewed literature, and/or calculated using widely accepted computer modeling programs. PHM was used for read-across as defined by the USEPA (1999b). All data were evaluated for study reliability in accordance with criteria outlined by the USEPA (1999a). Only studies that met the reliability criteria of "1" (reliable without restrictions) or "2" (reliable with restrictions) were used to fulfill OECD SIDS endpoints. Additional data for BZM and PHM are also included in the IUCLID (International Uniform Chemical Information Dataset) attached in Appendices I and II. A more detailed discussion of the data quality and reliability assessment process used to develop this test plan is provided in Appendix III.*

Summary: Adequate data (i.e., Klimisch rating 1 and 2) are available for all endpoints except Hydrolysis, Acute Toxicity to Fish, Acute Toxicity to Aquatic Plants, Repeated Dose, and Genetic Toxicity: *In vitro* Mammalian Cytogenetic Test. Additional testing with BZM is proposed to fulfill these six endpoints.

II. GENERAL SUBSTANCE INFORMATION

BZM is a member of the broader family of organomercaptans, which are also sometimes referred to as thiols or sulfhydryls. Many are naturally occurring and are characterized by their very strong malodor and low odor threshold (~1 ppb), a property that creates an immediate odor nuisance while keeping exposure and potential for adverse effects to humans at a minimum.

Today, CPChem is the major US producer of BZM, *and* CPChem annual production volumes are sold to one client. BZM is manufactured and transported in a closed system process and used as a chemical intermediate to produce agricultural pesticides, also in a closed system process. Traces or residues of BZM in end products are negligible as ppb amounts would introduce a malodor.

CPChem originally prepared documentation to substantiate that BZM is a closed system intermediate (CSI) pursuant to the USEPA's guidance for closed system intermediates for the HPV Challenge Program. However, CPChem dropped this approach based on the following two factors:

- It is unlikely the USEPA and the international community will accept closed system intermediate status and a reduced test package for BZM because CPChem's processing of BZM in the US is not site limited. The BZM is transported by railcar to another site, where it is a chemical intermediate in the production of agricultural pesticides.

- BZM is also approved by U.S. Food and Drug Administration (FDA) as a food additive. This is suggestive that specialty chemical distributors marketing natural BZM for this application may exist.

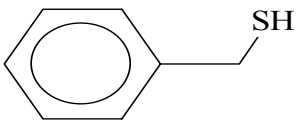
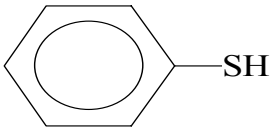
BZM CSI processes are confidential business information, but are available upon request for further evaluation by USEPA.

III. STRUCTURAL SURROGATE DISCUSSION

Because a substantial amount of data exists for BZM, it is possible to characterize several of the OECD SIDS hazard endpoints and to meet the requirements of the USEPA HPV Challenge Program. However, PHM also serves as a close structural surrogate to BZM and adds to the weight of evidence in characterizing many BZM physical/chemical, environmental, and human health-related endpoints.

Figure 1 presents the chemical structures for BZM and PHM. These substances are close structural analogs having the same functional groups. They differ only in the presence in BZM of a methylene group between the aromatic ring and the thiol group, which results in a difference in molecular weight of only 14 atomic mass units. The following sections illustrate that these surrogates have similar physical, chemical, environmental fate and effects, and toxicological properties. Given that PHM is slightly lower in molecular weight, it is slightly more water soluble, mobile, and bioavailable, making it a conservative read across benchmark with slightly higher toxicity than BZM. This is important because the trend is consistent and shows that where there are BZM data gaps, and PHM data are available for read-across purposes, additional testing on BZM will not provide new useful data.

Figure 1. Structural Comparison of Benzenemethanethiol and Benzenethiol

US HPV Chemical **Benzenemethanethiol** **(Benzyl Mercaptan / BZM)**	**Structural Surrogate** **Benzenethiol** **(Phenyl Mercaptan / PHM)**
	
CAS Number - 100-53-8 Molecular Weight = 124.20 SMILES: Scc (cccc1) c1	CAS Number - 108-98-5 Molecular Weight = 110.17 SMILES: Sc (cccc1) c1

IV. PHYSICOCHEMICAL PROPERTIES

The physical chemical data for BZM and PHM provided in Table 2 were experimentally confirmed or primarily obtained from well-established and scientifically accepted reference handbooks such as the Merck Index (O'Neil, 2001), Patty's Industrial Hygiene and Toxicology (Bingham, 2001), Sax's Dangerous Properties of Industrial Materials (Lewis, 2000), and the CRC Handbook of Chemistry and Physics (Lide, 2001-2002), as

well as EPIWIN-calculated values (USEPA and Syracuse Research Corporation, 2000). These data show that both BZM and PHM are moderately water soluble and have similar melting and boiling points, vapor pressure, and hydrophobicity (log Kow).

Table 2. Measured (M) and Calculated (C) Physicochemical Properties

Physical and Chemical Data				
Test	**M/C**	**BZM**	**M/C**	**PHM**
Melting Point	M[1] C[2]	-30 ºC -19.22 ºC	M[3,4] M[1] C[2]	-14.8 to -14.9 ºC -14.9 ºC -31.86 ºC
Boiling Point	M[4,5] M[1] C[2]	194-195 ºC 194.5 ºC 200.14 ºC	M[3,4,6] M[1] C[2]	168.7 to 169.5 ºC 169.1 ºC 176.14 ºC
Vapor Pressure	C[2]	0.474 mmHg (0.632 hPa)	M[4] M[1] C[2]	2.67 hPa at 25 ºC 1.93 mmHg (2.57 hPa) 1.63 mmHg (2.17316 hPa)
Kow Partition Coefficient	C[7]	2.48	M[8] M[1] C[7]	2.52 2.52 2.69
Water Solubility	C[9]	732.2 mg/L (at 25 ºC)	M[3] M[1] C[9]	1 at 25 ºC 835 mg/L (at 25 ºC) 765.5 mg/L (at 25 ºC)

[1] EPIWIN v3.10; measured values from the EPIWIN experimental database.
[2] EPIWIN v3.10; calculated using MPBPWIN v1.40 (determined at 760 millimeter mercury [mmHg]).
[3] Lide, 2001-2002.
[4] Bingham, 2001.
[5] O'Neil, 2001.
[6] Lewis, 2000.
[7] EPIWIN v3.10; calculated using KOWWIN v1.66.
[8] Sangster, 1989.
[9] EPIWIN v3.10; calculated using WSKOW v1.40.

Summary: Adequate data (i.e., Klimish rating 1 and 2) are available for all endpoints; no additional testing is proposed for the USEPA HPV Challenge Program (see Table 2 and IUCLID documents).

V. EVALUATION OF ENVIRONMENTAL FATE DATA

Environmental fate data for BZM and PHM were either experimentally measured or estimated using EPIWIN, and are provided in Tables 3, 3a, and 3b. Overall, these substances are expected to be mobile if released to the environment, but they will ultimately degrade based upon both biotic and abiotic degradation mechanisms and do not pose any bioaccumulation hazard.

Table 3. Results for Environmental Fate and Pathways

Environmental Fate and Pathways				
Test	**M/C**	**BZM**	**M/C**	**PHM**
Photodegradation & Atmospheric Oxidation: • OH Rate Constant • OH Half Life	 C[1] C[1]	 44.63 x 10^{-12} cm^3/molecule-sec 2.876 Hrs	 C[1] C[1]	 11.32 x 10^{-12} cm^3/molecule-sec 11.34 Hrs
Stability in Water (Hydrolysis)		No Data Available		No Data Available
Transport/ Distribution • Fugacity • Estimated Koc: • Estimated BCF:	 C[2] C[3]	 See model results below (Table 3a) 518 16.32	 C[2] C[3]	 See model results below (Table 3b) 268 17.39
Biodegradation	M[4]	40.7% in 28 days (Closed Bottle - OECD 301d)		No Data Available

[1]EPIWIN v3.10; calculated using AOP Program v1.40.
[2]EPIWIN v3.10; calculated using PCKOC Program v1.66.
[3]EPIWIN v3.10; calculated using BCF Program v2.14.
[4] Elf Atochem S.A. Benzyl mercaptan,determination de la biodegradabilite facile,essai en fioles fermees.centre d'application de levallois,le 11/09/96

A. Photodegradation – Atmospheric Oxidation

Values for BZM photodegradation and atmospheric oxidation were calculated based upon chemical structures using EPIWIN and are shown in Table 3. A calculated half-life for BZM of 2.876 hours and rate constant of 44.63 x 10^{-12} cubic centimeter (cm^3)/molecule-sec has been estimated for reaction with hydroxyradicals, compared to a calculated half-life for PHM of 11.34 hours and a rate constant of 11.32 x 10^{-12} cm^3/molecule-sec.

Summary: These results are sufficient for USEPA HPV Challenge Program, and no further testing is warranted.

B. Hydrolysis

BZM and PHM are both water soluble and are expected to be stable in water at environmentally relevant pHs. EPIWIN was unable to calculate a hydrolysis rate constant for either structure due to the absence of functional groups that are labile to hydrolysis.

Summary: Testing for Stability in Water (OECD Test Guideline 111) is recommended for BZM to fulfill this endpoint.

C. Chemical Transport and Distribution in the Environment (Fugacity Modeling)

Tables 3a and 3b summarize the Level III Fugacity results for BZM and PHM produced by EPIWIN.

Table 3a. EPIWIN Level III Fugacity Results for BZM

Compartment	100% to air	100% to water	100% to soil	Equally to each compartment
Air	92.6%	0.87%	0.22%	1.54%
Water	6.13%	98.6%	1.85%	36.0%
Soil	1.2%	0.01%	97.9%	62.3%
Sediment	0.03%	0.51%	0.01%	0.19%

Table 3b. EPIWIN Level III Fugacity Results for PHM

Compartment	100% to air	100% to water	100% to soil	Equally to each compartment
Air	94.4%	3.43%	1.01%	5.37%
Water	4.58%	96.0%	1.61%	34.2%
Soil	0.99%	0.04%	97.4%	60.3%
Sediment	0.03%	0.52%	0.01%	0.19%

Summary: Results from the Level III fugacity modeling indicate that releases to water would remain in water while releases to air and soil would partition to water and soil. These results also show that both compounds behave similarly in the environment and that further fugacity modeling is not warranted.

D. Biodegradation and Bioaccumulation

BZM has been tested in a Ready Biodegradation test, and the results are reliable without restrictions and fulfill the HPV SIDS endpoint for BZM. The results are also in agreement with EPIWIN calculated results. BZM should be inherently biodegradable under real-world aerobic and anaerobic conditions. However, under the conservative conditions of the standard OECD ready tests, BZM was shown not to be readily biodegradable.

The EPIWIN predicted bioconcentration factor (BCF) and organic carbon partition coefficients (Koc) are similar for BZM and PHM, suggesting that both are nonsorptive in the environment and pose no bioaccumulation hazard.

Summary: These results are sufficient for USEPA HPV Challenge Program purposes, and no further testing is warranted (See Table 3 and IUCLID Documents).

Environmental Fate and Pathways Summary: Adequate data (i.e., Klimisch rating 1 and 2) are available for all environmental fate endpoints with the exception of Stability in Water (Hydrolysis), for which testing is proposed consistent with OECD Test Guideline 111.

VI. ECOTOXICITY DATA

Table 4 shows that only limited experimental aquatic toxicity testing of BZM and PHM has been conducted. One aquatic study was performed on aquatic invertebrates (*Daphnia*). However, within EPIWIN, the ECOSAR module recognizes BZM as a member of both the Neutral Organic and Thiols (or Mercaptan) chemical classes and recognizes PHM as a member of both the Neutral Organic and Phenols chemical classes. ECOSAR has validated fish Quantitative Structure Activity Relationship (QSAR) and *Daphnia* acute toxicity endpoints for these classes that add perspective, but clear trends are not evident.

Table 4. Results for Ecotoxicity Endpoints

Ecotoxicity		
Test	**BZM**	**PHM**
AcuteToxicity to Fish	96-hr LC_{50} = 64 mg/L[1] 96-hr LC_{50} = 0.920 mg/L[2]	96-hr LC_{50} = 37 mg/L[1] 96-hr LC_{50} = 6.082 mg/L[3]
Acute Toxicity to Aquatic Invertebrates (Daphnid)	24 hr EC_{50} > 0.26 mg/L[4] 48 hr EC_{50} = 0.15 mg/L[4] 48-hr EC_{50} = 0.045 mg/L[2]	48-hr EC_{50} = 3.097 mg/L[3]
Acute Toxicity to Aquatic Plants (Algae)	No Data Available	96-hr EC_{50} = 13.4 mg/L[3]

[1] EPIWIN v3.10; calculated using ECOSAR Program for neutral organic chemicals.
[2] EPIWIN v3.10; calculated using ECOSAR Program for mercaptans.
[3] EPIWIN v3.10; calculated using ECOSAR Program for phenols.
[4] Elf Atochem S.A. 1997.

Ecotoxicity Summary: Sufficient data is available to warrant no further acute toxicity testing with aquatic invertebrates. Additional testing is proposed (OECD Guidelines 203 and 201) to meet the Acute Fish and Acute Aquatic Plants (Algae) HPV SIDS endpoints.

VII. MAMMALIAN TOXICITY

A limited amount of existing mammalian toxicity information on BZM and PHM demonstrates that PHM is a conservative read across benchmark, with slightly higher toxicity than BZM. The increased toxicity of PHM is likely due to its physicochemical characteristics; PHM has a slightly lower molecular weight, and is slightly more water soluble, mobile, and bioavailable than BZM. This is important because the trend is consistent and shows that where there are BZM data gaps in mammalian toxicity information, and PHM data are available for read-across purposes, additional testing on BZM will not provide new useful data.

Table 5. Results for Mammalian Toxicity Endpoints

Mammalian Toxicity		
Test	**BZM**	**PHM**
Acute Oral	LD_{50} 1 day = 985 mg/kg[1] LD_{50} 15 day = 493 mg/kg[1]	LD_{50} = 46.2 mg/kg[1]
Acute Inhalation	A. Rat LC_{50}: not calculable (one death out of 6 rats at 185 ppm and one death out of 6 rats at 235 ppm.[1] B. Mouse LC_{50} (24 hr): 195 ppm[1] Mouse LC_{50} (15 day): 178 ppm[1]	A. Rat LC_{50} (48 hr): 59 ppm[1] Rat LC_{50} (15 day): 33 ppm[1] B. Mouse LC_{50} (24 hr): 47 ppm[1] Mouse LC_{50} (48 hr): 35.5 ppm[1] Mouse LC_{50} (15 day): 28 ppm[1]
Acute Dermal	Rat LD_0: ≥ 2000 mg/kg[2]	Rat LD_{50}: 300 mg/kg[1]
Acute (i.p.)	LD_{50} 1 day = 429 mg/kg[1] LD_{50} 15 day = 373 mg/kg[1]	LD_{50} 1 day = 25.2 mg/kg[1] LD_{50} 15 day = 9.8 mg/kg[1]
Repeated Dose	No Data Available	No Data Available
Reproduction Toxicity	No Data Available	Reproductive toxicant both in males (based on increased incidence of inhibited spermiation in all treated F_1 males, and decreased epididymal sperm motility in the mid- and high dose [18 and 35 mg/kg] F_0 males) and in females (developmental -- based on decreased pup weights).[3]
Developmental Toxicity	No Data Available	A. Rat Maternal LOAEL: 20 mg/kg/day[4]; Rat Fetal NOAEL: 20 mg/kg/day[4] B. Rabbit Maternal NOAEL: 10 mg/kg/day[5]; Rabbit Fetal NOAEL: 40 mg/kg/day[5]
Genetic – Gene Mutation	Negative[6]	No Data Available

Mammalian Toxicity		
Test	**BZM**	**PHM**
Genetic – Chromosomal Aberration	No Data Available	No Data Available

[1] Fairchild and Stokinger, 1958.
[2] Centre International de Toxicologie, 1996.
[3] National Toxicology Program, 1996.
[4] National Toxicology Program, 1994a.
[5] National Toxicology Program, 1994b.
[6] Wild et al., 1983.
LOAEL = lowest observed adverse effect level.
NOAEL = no observed adverse effect level.

A. Acute Toxicity

Acute toxicity studies show that BZM is of low acute toxicity by the oral, inhalation, dermal, and interperitoneal routes (see Table 5 and IUCLID documents). Importantly, the close structural analogue PHM was also tested and consistently shows higher acute toxicity than BZM.

Summary: These studies fulfill the HPV requirements for the acute toxicity endpoint; no additional testing is proposed for the USEPA HPV Challenge Program.

B. Repeated Dose Toxicity

No repeated dose toxicity studies were identified for either BZM or its structural surrogate, PHM. As discussed in other sections, BZM will not be considered a closed system intermediate and therefore testing for this endpoint is proposed.

Summary: Additional testing is proposed for this endpoint consistent with OECD Guideline 407 (Repeated Dose 28-day Oral Toxicity Study in Rodents).

C. Genetic Toxicity/Mutagenicity

A valid *in vitro* gene mutation study (*Salmonella typhimurium* Reverse Mutation Assay) was performed for BZM and showed no mutagenic activity. No *in vitro* chromosomal aberration studies were identified for either BZM or PHM. The USEPA requires two different endpoints to be tested: gene mutation and chromosomal aberration. As a result, testing is proposed to meet the chromosomal aberration requirements.

Summary: Additional testing is proposed for this endpoint consistent with OECD Guideline 473 (Genetic Toxicology: *In vitro* Mammalian Cytogenetic Test) in order to meet the chromosomal aberration endpoint requirements.

D. Reproductive Toxicity

BZM has not been tested for reproductive toxicity. However, due to its close structural similarity to PHM, as well as the demonstrated higher level of acute toxicity of PHM, it would be expected that BZM would be of a similar order of magnitude as PHM, if not of lower reproductive toxicity. As a result, data for the structural surrogate PHM can be used as read-across data for BZM, and no further testing of BZM is warranted for this endpoint (see Table 5 and IUCLID Documents).

PHM was tested by the National Toxicology Program (1996) for reproductive toxicity in rats. This study followed the National Toxicology Program's Reproductive Assessment by Continuous Breeding (RACB) protocol and was found to be valid without restriction. PHM was determined to be a slight reproductive toxicant both in males (based on increased incidence of inhibited spermiation in all treated F_1 males, and decreased epididymal sperm motility in the mid- and high dose [18 and 35 mg/kg] F_0 males) and in females (developmental – based on decreased pup weights). Results of this study also show that PHM is not a selective reproductive toxicant because the minor effects on reproduction occurred concomitant with, or at doses greater than, those doses that produce hepatic or renal toxicity.

Summary*:* Adequate data (i.e., Klimisch rating 1) are available for this endpoint. Data for the structural surrogate PHM can be used as read-across data for BZM, and no further testing of BZM is warranted for this endpoint (see Table 5 and IUCLID Documents).

E. Developmental Toxicity

PHM was tested by the National Toxicology Program (1994a; 1994b) for developmental toxicity in both rats and rabbits. These studies followed OECD Guideline 414 and were found to be valid without restriction (Klimisch 1). In rats, the maternal LOAEL was 20 mg/kg/day, and the fetal NOAEL was 20 mg/kg/day. Maternal toxicity (observed as maternal mortality), a persistent decrease in body weight and weight gain, and a decrease in food consumption during the treatment period occurred at the high-dose level of 50 mg/kg/day. The LOAEL (20 mg/kg/day) for maternal toxicity was based on minor, transient decreases in maternal weight gain and food consumption on gestation day (gd) 6 to 9. The maternal NOAEL could not be determined based upon the doses evaluated. Developmental toxicity, observed as increased post-implantation death, decreased litter size, decreased fetal body weight, and an increase in the incidence of external malformations, occurred only at the high dose. Reduced female fetal body weight was observed at 35 mg/kg/day, suggesting an NOAEL of 20 mg/kg/day.

In rabbits, the maternal NOAEL was 10 mg/kg/day, and the fetal NOAEL was 40 mg/kg/day. The 40 mg/kg/day PHM did not adversely affect the growth, viability, or morphological development of the offspring. As a result, the developmental toxicity in this study was $\geq$ 40 mg/kg/day; the LOAEL could not be determined at the doses

evaluated. Maternal toxic effects at 30 and 40 mg/kg/day were minor and transient; therefore, the evidence of toxicity was equivocal. However, a slightly higher dose of 50 mg/kg/day was found to be excessively toxic, resulting in maternal morbidity and mortality. Evaluation of developmental toxicity at doses above 40 mg/kg/day was precluded by excessive maternal toxicity.

BZM has not been tested for developmental toxicity. However, due to its close structural similarity to PHM, as well as the demonstrated higher level of acute toxicity of PHM, it would be expected that BZM would be of a similar order of magnitude as PHM, if not of lower developmental toxicity.

Summary: Data for the structural surrogate PHM can be used as read-across data for BZM, and no further testing of BZM is warranted for this endpoint (see Table 5 and IUCLID Documents).

Mammalian Toxicity Summary: Sufficient mammalian toxicity data exist for BZM and PHM for all SIDS Mammalian Toxicity Endpoints except repeated dose and genetic toxicity. Additional testing (OECD Guidelines 407 and 473) is proposed to fulfill these two SIDS endpoints.

VIII. "BEYOND SIDS" ENDPOINTS:

Studies have been performed to investigate skin irritation and skin sensitization potential (see IUCLID document).

IX. CONCLUSIONS

As summarized below, CPChem concludes that there are sufficient, reliable data on BZM and its structural surrogate, PHM, for many of the SIDS endpoints following a thorough review of company proprietary files, the peer-reviewed literature, and/or calculations using widely accepted computer modeling programs.

- **PHYSICOCHEMICAL DATA**. Physicochemical endpoints for BZM are fulfilled by using existing measured data or data calculated by the EPIWIN© computer model. No additional testing is proposed.

- **ENVIRONMENTAL FATE**. Sufficient data are available to characterize environmental fate endpoints, with the exception of hydrolysis, for BZM. An estimation from a Level III fugacity model predicts that both BZM, as well as its structural surrogate PHM, will likely partition to soil and water. Ready biodegradation testing showed that BZM is not readily biodegradable and the predicted bioconcentration factors and organic carbon partition coefficients for BZM and PHM suggest similar fate profiles in the environment and a slight

bioaccumulation hazard for either BZM or PHM. Additional testing for the hydrolysis endpoint is proposed.

- **ACUTE AQUATIC TOXICITY**. Only limited acute aquatic toxicity data are available for BZM and PHM. Additional acute toxicity testing for fish and aquatic plants is proposed for BZM.

- **ACUTE MAMMALIAN TOXICITY**. Mammalian toxicity data demonstrates a low order of toxicity via oral, dermal, and inhalation routes of exposure. Sufficient data are available to fulfill the acute toxicity endpoint for BZM and no additional testing is proposed.

- **GENETIC TOXICITY**. Limited genetic toxicity data is available for BZM. Additional testing using an *in vitro* chromosomal aberration assay is proposed.

- **REPEATED DOSE TOXICITY**. No repeated dose toxicity testing data for BZM or PHM was identified. Additional testing for this endpoint is proposed.

- **REPRODUCTIVE AND DEVELOPMENTAL TOXICITY**. BZM has not been tested for reproductive and developmental toxicity, but, due to its close structural similarity to PHM, it would be expected to be of a similar order of magnitude as PHM. Given that PHM is characterized for this endpoint and is expected to produce results of the same order of magnitude, PHM can be used as a structural surrogate for BZM, and no further BZM testing is warranted for this endpoint.

Test Plan Summary: Additional testing with BZM is proposed to fulfill the following five endpoints:

- **Hydrolysis (OECD 111);**
- **Acute Toxicity to Fish (OECD 203);**
- **Acute Toxicity to Aquatic Plants (OECD 201);**
- **Repeated Dose (OECD 407); and**
- **Genetic Toxicity: *In vitro* Mammalian Cytogenetic Test (OECD 473).**

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201-15166B

Appendix I

Benzyl Mercaptan

I U C L I D

Data Set

Existing Chemical	:	ID: 100-53-8
CAS No.	:	100-53-8
EINECS Name	:	toluene-alpha-thiol
EINECS No.	:	202-862-5
Molecular Formula	:	C7H8S
Producer Related Part		
Company	:	Chevron Phillips Chemical Company LP
Creation date	:	24.11.2003
Substance Related Part		
Company	:	Chevron Phillips Chemical Company LP
Creation date	:	24.11.2003
Memo	:	
Printing date	:	06.01.2004
Revision date	:	
Date of last Update	:	06.01.2004
Number of Pages	:	63
Chapter (profile)	:	Chapter: 1, 2, 3, 4, 5, 7
Reliability (profile)	:	Reliability: without reliability, 1, 2, 3, 4
Flags (profile)	:	Flags: without flag, confidential, non confidential, WGK (DE), TA-Luft (DE), Material Safety Dataset, Risk Assessment, Directive 67/548/EEC, SIDS

1.0.1 OECD AND COMPANY INFORMATION

Type : other
Name : Chevron Phillips Chemical Company LP
Partner :
Date :
Street : 10001 Six Pines Drive
Town : 77380 The Woodlands, TX
Country : United States
Phone :
Telefax :
Telex :
Cedex :
24.11.2003

1.2 SYNONYMS

(Mercaptomethyl) benzene
24.11.2003

alpha-Toluenethiol
24.11.2003

alpha-Tolyl mercaptan
05.12.2003

Benzyl mercaptan
24.11.2003

Benzylhydrosulfide
24.11.2003

Benzylthiol
24.11.2003

Phenylmethanethiol
24.11.2003

Phenylmethyl mercaptan
24.11.2003

Thiobenzyl alcohol
24.11.2003

2.1 MELTING POINT

Value	:	= -30 ° C
Sublimation	:	
Method	:	other: EPIWIN v 3.10
Remarks		Selected Melting Point (calculated mean value) was -19.22 ºC.
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	MPBPWIN (v 1.40) Experimental Melting Point
Source	:	EPI Suite v 3.10.
Test substance	:	Benzenemethanethiol (CAS Number 100-53-8)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (14)

2.2 BOILING POINT

Value	:	= 194 - 195 ° C
Decomposition	:	
Method	:	other: no data
Year	:	
GLP	:	no data
Test substance	:	other TS
Source	:	Patty's Industrial Hygiene and Toxicology (Bingham, 2001).
Test substance	:	Benzyl Mercaptan (CAS Number 100-53-8), purity not given
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (2)

Value	:	= 194 - 195 ° C
Decomposition	:	
Method	:	other: no data
Year	:	
GLP	:	no data
Test substance	:	other TS
Source	:	The Merck Index (O'Neil, M.J., 13th ed.)
Test substance	:	Benzyl mercaptan (Thiobenzyl Alcohol) CAS Number 100-53-8, purity not given
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

26.11.2003 (13)

Value	:	= 194.5 ° C
Decomposition	:	
Method	:	other: EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	MPBPWIN (v 1.40) Experimental Boiling Point
Remarks		The Boiling Point was calculated to be 200.14 ºC using the Adapted Stein & Brown Method.
Source	:	EPI Suite v 3.10.
Test substance	:	Benzenemethanethiol (CAS Number 100-53-8)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (14)

2.4 VAPOUR PRESSURE

Value	:	= 0.632 hPa at 25° C
Decomposition	:	
Method		other (calculated): EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	EPIWIN Selected Vapor Pressure (Mean of Antoine & Grain methods). Vapor Pressure Estimations (25 deg C) using BP: 194.50 deg C.
Result	:	0.474 mm Hg (0.632 hPa) at 25 deg C.
Source	:	EPI Suite v 3.10.
Test substance	:	Benzenemethanethiol (CAS Number 100-53-8)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

31.12.2003 (14)

2.5 PARTITION COEFFICIENT

Log pow	:	= 2.48
Method		other (calculated): EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	WSKOW v 1.40, EPIWIN v 3.10.
Source	:	EPI Suite v 3.10.
Test substance	:	Benzenemethanethiol (CAS Number 100-53-8)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

26.11.2003 (14)

2.6.1 WATER SOLUBILITY

Value	:	= 732.2 mg/l at 25 ° C
Qualitative	:	moderately soluble (100-1000 mg/L)
Pka	:	
PH	:	
Method	:	other: EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	Water Solubility calculated from Kow (WSKOW v1.40).
Source	:	EPI Suite v 3.10.
Test substance	:	Benzenemethanethiol (CAS Number 100-53-8)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

31.12.2003 (14)

3.1.1 PHOTODEGRADATION

Type	:	other
Light source	:	
Light spect.	:	
Rel. intensity	:	
Deg. Product	:	
Method	:	other (calculated): EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	Calculated using EPIWIN v 3.10, AOP Program v 1.90.
Result	:	Overall OH Rate Constant = 44.6303 E-12 cm3/molecule-sec Half-Life = 0.240 Days (12-hr day; 1.5E6 OH/cm3) Half-Life = 2.876 Hrs
Source	:	EPI Suite v 3.10.
Test substance	:	Benzenemethanethiol (CAS Number 100-53-8)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

31.12.2003 (14)

3.3.1 TRANSPORT BETWEEN ENVIRONMENTAL COMPARTMENTS

Type	:	fugacity model level III
Media	:	other: air-water-soil-sediment
Air (level I)	:	
Water (level I)	:	
Soil (level I)	:	
Biota (level II / III)	:	
Soil (level II / III)	:	
Method	:	other: EPIWIN v 3.10
Year	:	2003
Method	:	Used EPIWIN v 3.10. The following physical properties were used as the model input parameters: Chem Name: Benzenemethanethiol Molecular Wt: 124.2 Henry's LC: 0.000211 atm-m3/mole (Henrywin program) Vapor Press: 0.474 mm Hg (Mpbpwin program) Log Kow: 2.48 (Kowwin program) Soil Koc: 124 (calc by model)
Result	:	Results are provided in the following format: Compartment / 100% to Air / 100% to Water / 100% to Soil / Equally to Each Compartment Air / 92.6% / 0.873% / 0.22% / 1.54% Water / 6.13% / 98.6% / 1.85% / 36.0% Soil / 1.2% / 0.011% / 97.9% / 62.3% Sediment / 0.03% / 0.51% / 0.0096% / 0.19% Air: half life = 5.75 hr; emissions = 1000 kg/hr

Water: half life = 360 hr; emissions = 1000 kg/hr
Soil: half life = 360 hr; emissions = 1000 kg/hr
Sediment: half life = 1.44E+3 hr; emissions = 0 kg/hr

Persistence when distributed equally to each compartment = 235 hr
(Emissions (kg/hr) = 1000 to air, 1000 to water, 1000 to soil, and 0 to sediment)

Source : EPI Suite v 3.10.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
26.11.2003 (14)

3.5 BIODEGRADATION

Type : aerobic
Inoculum :
Contact time :
Degradation : = 40.7% after 28 days
Result : other: not readily biodegradable.
Kinetic of test substance :
7 day = 2.8**%**
15 day = 0.8**%**
21 day = 5.5**%**
28 day = 40.7**%**

Control substance : Benzoic acid, sodium salt
Kinetic : 7 day > 100**%**
28 day > 100**%**
Deg. Product : not measured
Method : OECD Guide-line 301 D "Ready Biodegradability: Closed Bottle Test"
Year : 1992
GLP : no data
Test substance : other TS

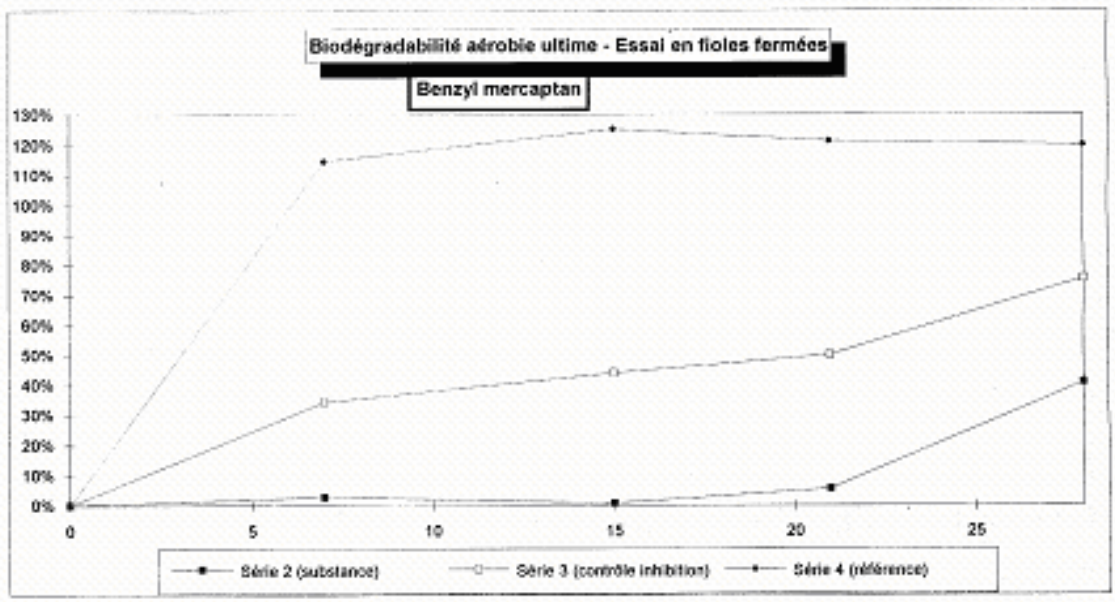
Source : ATOFINA, PARIS-PARIS-LA-DEFENSE, FRANCE

Test condition : DURATION OF THE TEST: 28 days
ANALYTICAL PARAMETER: The bacterial activity is evaluated by the consumption of dissolved O2, and the degradation follows from the difference between its consumption in flasks containing test substance and check flasks.
SAMPLING: 7, 15, 21, 28 days.

Test substance : Benzyl Mercaptan, CAS# 100-53-8, purity not given

Attached doc. : Courbe Benzyl mercaptan.bmp
Tableaux resultats Benzyl mercaptan.bmp

4353C4E.XLS Graphique 2



Page 1

4353C4E.XLS

BIODÉGRADABILITÉ "FACILE"
ESSAI EN FIOLES FERMÉES
Directive CEE 92/69 : C.4-E - Ligne Directrice OCDE 301 D

SUBSTANCE D'ESSAI :	**Benzyl mercaptan**	N°CAL :	4353/96
Substance de référence :	Benzoate de sodium		

MESURES DE L'OXYGÈNE DISSOUS

Série	Fiole	Temps (j) 0	7	15	21	28
1 - Milieu + inoculum						
	1	8,8	8,5	8,3	8,1	8,0
	2	8,8	8,6	8,4	8,1	8,0
	Moyenne	8,8	8,6	8,4	8,1	8,0
2 - Milieu + inoculum + substance d'essai						
	1	8,5	8,1	8,1	7,9	5,0
	2	8,5	8,1	7,9	7,8	4,9
	3	8,5	8,0	8,0	6,6	5,1
	Moyenne	8,5	8,1	8,0	7,4	5,0
3 - Milieu + inoculum + substance d'essai + substance de référence						
	1	8,7	6,5	5,1	3,9	2,6
	2	8,6	5,7	5,4	5,3	3,0
	Moyenne	8,7	6,1	5,3	4,6	2,8
4 - Milieu + inoculum + substance de référence						
	1	8,8	0,9	0,0	0,0	0,0
	2	8,8	0,9	0,0	0,0	0,0
	Moyenne	8,8	0,9	0,0	0,0	0,0

	DCO ou DThO (mgO2/mg)	Concentration (mg/l) Série 2	Série 3	Série 4
Benzyl mercaptan	2,71	2,45	1,24	
Benzoate de sodium	1,67		2	4
Série 3	2,07			

DBO spécifique (mg d'oxygène consommé par mg de substance)

Temps (j) :	0	7	15	21	28
Série 2 (substance)	0,00	0,07	0,02	0,15	1,10
Série 3 (contrôle inhibition)	0,00	0,71	0,91	1,03	1,56
Série 4 (référence)	0,00	1,91	2,09	2,03	2,00

BIODÉGRADATION (moyenne des fioles)

Temps (j) :	0	7	15	21	28
Série 2 (substance)	0%	2,8%	0,8%	5,5%	40,7%
Série 3 (contrôle inhibition)	0%	34,3%	44,0%	50,0%	75,4%
Série 4 (référence)	0%	114,5%	125,0%	121,3%	119,8%

CLAUSES DE VALIDITÉ DE L'ESSAI

Consommation d'oxygène dans la série 1 < 1,5 mg/l à 28 jours :	oui
Concentration résiduelle dans les séries d'essais > 0,5 mg/l :	oui

Page 1/2

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
06.01.2004 (3)

3.7 BIOACCUMULATION

BCF	:	16.32
Elimination	:	
Method	:	other: calculated using EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	Calculated using BCF Program (v 2.14)
Remark	:	Estimated Log BCF = 1.213 Estimated Koc = 518 (using PCKOC Program [v 1.66])
Source	:	EPI Suite v 3.10.
Reliability	:	(2) valid with restrictions

31.12.2003 (14)

4.1 ACUTE/PROLONGED TOXICITY TO FISH

Type	:	other: ECOSAR Predicted LC50
Species	:	other: Fish
Exposure period	:	14 days
Unit	:	mg/l
Analytical monitoring	:	
LC50	:	c = 63.687
Method	:	other: calculated using EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS

Method : ECOSAR Program (v 0.99g).

The following physical parameters were used:
Molecular Weight: 124.2
Log Kow: 2.48 (KowWin estimate)
Water Solubility: 178.9 mg/L (calculated)

Result : ECOSAR Class: Neutral Organic SAR (Baseline Toxicity)
Organism: Fish
Duration: 14-day
LC50: 63.687 mg/L (ppm)

Source : EPI Suite v 3.10.

Test substance : Benzenemethanethiol (CAS Number 100-53-8)

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
05.12.2003 (14)

Type	:	other: ECOSAR Predicted LC50
Species	:	other: Fish
Exposure period	:	96 hour(s)
Unit	:	mg/l
Analytical monitoring	:	
LC50	:	c = 0.92
Method	:	other: calculated using EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS

Method : ECOSAR Program (v 0.99g).

The following physical parameters were used:
Molecular Weight: 124.2
Log Kow: 2.48 (KowWin estimate)
Water Solubility: 178.9 mg/L (calculated)

Result : ECOSAR Class: Thiols (mercaptans)
Organism: Fish
Duration: 96-hr
LC50: 0.920 mg/L (ppm)

Source : EPI Suite v 3.10.

Test substance : Benzenemethanethiol (CAS Number 100-53-8)

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
05.12.2003 (14)

4.2 ACUTE TOXICITY TO AQUATIC INVERTEBRATES

Type : static
Species : Daphnia magna (Crustacea)
Exposure period : 48 hour(s)
Unit : mg/l
Analytical monitoring : yes
EC50 : c = 0.15
EC50, 24h : c = 0.26
Method : OECD Guide-line 202, part 1 "Daphnia sp., Acute Immobilisation Test"
Year : 1984
GLP : yes
Test substance : other TS

Result : RESULTS: EXPOSED
- Nominal/measured concentrations: Attached document.
- Effect data (Immobilisation): Attached document.

RESULTS: TEST WITH REFERENCE SUBSTANCE: The sensibility of the biologic reactive is controlled by a toxicity test with Potassium dichromate periodically.
- Concentrations: EC50/24h = 0.94 mg/l.

Source : ATOFINA, PARIS-PARIS-LA-DEFENSE, FRANCE

Test condition : TEST ORGANISMS
- Strain: Daphnia magna (crustacea) straus strain 5 or strain A.
- Source/supplier: Breeding colony was realized in the laboratory, organisms were selected by sieving.
- Breeding method: Not available.
- Age: Less than 24 hours.
- Feeding: Microscopic algae Raphidocelis subcapitata.
- Pretreatment: No.
- Feeding during test: No.
- Control group: Yes.

STOCK AND TEST SOLUTION AND THEIR PREPARATION
- Dispersion: No.
- Vehicle, solvent: No.
- Concentration of vehicle/ solvent: None.
- Other procedures: 100 mg of the substance were introduced in 1 litre of dilution water, stirred at 20°C during 24 hours. Daphnids were exposed to a concentration range of 0.08 to 8.45 mg/l forming a geometric progression with a factor of 1.8.

STABILITY OF THE TEST CHEMICAL SOLUTIONS: The concentrations had been maintained to within 80% of the initial concentration throughout the duration of the test.
REFERENCE SUBSTANCE: Potassium dichromate.
DILUTION WATER: was prepared in the laboratory using pure water and salts according to ISO 6341.
For one litre: 25 ml of the below solutions
1- 11.76g $CaCl_2, 2H_2O$/l ultrapure water.
2- 4.93g $MgSO_4, 7H_2O$/l ultrapure water.
3- 2.59g $NaHCO_3$/l ultrapure water.
4- 0.23g KCl/l ultrapure water.
- Aeration: aerated up until oxygen saturation.
- Ca/Mg ratio: 4.

- Na/K ratio: 10.
TEST SYSTEM
- Concentrations: Attached document.
- Renewal of test solution: No.
- Exposure vessel type: 120 ml closed flasks (as test glassware) were entirely filled with test solutions and closed with butyl rubber caps covered with PTFE.
- Number of replicates, individuals per replicate: 4 replicates and 5 daphnids by replicate.
- Test temperature: 19.5-20.5°C.
- Dissolved oxygen: > 2 mg/l.
- pH: 7.97-8.17.
- Adjustment of pH: No.
- Photoperiod: Incubation of test flasks in darkness.
DURATION OF THE TEST: 24 and 48 hours.
TEST PARAMETER: The percentage of daphnids immobilisation after 24 and 48 hours.
SAMPLING: 24, 48 hours.
MONITORING OF TEST SUBSTANCE CONCENTRATION: CPG.

Test substance : Benzyl Mercaptan, CAS# 100-53-8, 99.45% pure.

Attached doc. : Benzylmercaptan.bmp
Summary Benzylmercaptan.bmp

Elf Atochem S. A.
Centre d'Application de Levallois

Concentration				Immobilisation	
Nominale	Calculée				
vol. solution. saturée (%)	Initiale (mg/l)	Finale (mg/l)	Final/Initial %	à 24 h (%)	à 48 h (%)
10	8.45	8.08	96	100	100
5.56	4.69	4.49	96	100	100
3.09	2.61	2.50	96	75	100
1.71	1.45	1.39	96	75	100
0.95	0.80	0.77	96	80	100
0.53	0.45	0.43	96	75	100
0.29	0.25	0.24	96	55	85
0.16	0.14	0.13	93	25	15
0.09	0.08	0.07	88	25	20
0	0	0	/	5	0

Les bulletins d'analyses sont joints en annexe 4.

Les résultats obtenus dans l'essai sont rassemblés dans les tableaux en annexe 2 (résultats à 24 heures) et en annexe 3 (résultats à 48 heures). La partie supérieure montre les données brutes obtenues ; les concentrations utilisées pour les calculs (concentrations calculées) sont indiquées en dessous. Après linéarisation au moyen de la méthode des Probits, on obtient les résultats suivants :

CE_{50}-24h = 0,26 mg/l,
avec un intervalle de confiance à 95 % égal à : 0,079 - 0,51 mg/l (r^2 = 0,806)

CE_{50}-48h = 0,15 mg/l,
avec un intervalle de confiance à 95 % indéterminé (r^2 = 0,868)

Elf Atochem S. A.
Centre d'Application de Levallois

TECHNICAL SUMMARY

The acute toxicity (inhibition of mobility) of BENZYLMERCAPTAN for *Daphnia magna* was assessed according to the method C2 of the European Directive 92/69/CEE. The study was carried out in compliance with the Principles of OECD Good Laboratory Practices.

Daphnia were exposed in a static test to a concentration range of 0,08 to 8,45 mg/l, forming a geometric progression with a factor of 1,8. The test was performed with 5 daphnia per vessel. Since BENZYLMERCAPTAN is volatile, the test was performed using closed flasks as test glassware. In order to avoid volatilisation of BENZYLMERCAPTAN flasks were entirely filled with test solutions and closed with butyl rubber caps covered with PTFE.

For each exposure concentration, the percentage of immobilisation at 24 hours and 48 hours was recorded. The test concentrations of BENZYLMERCAPTAN were measured by CPG according to the analytical method described in the attached report. EC_{50}-24h and EC_{50}-48h were calculated with measured initial concentrations by regression analysis using the Probit/log model.

The EC_{50}-24h was calculated to be 0,26 mg/l with 95 % confident interval ranging from 0,079 to 0,51 mg/l.

The EC_{50}-48h was calculated to be 0,15 mg/l with 95 % confident interval ranging indetermined.

The method was applied with respect to its quality criteria :

- Immobilisation in the control did not exceed 10 % at the end of the test ;
- Concentration of dissolved oxygen in the test vessels remained above 2 mg/l at the end of the test and pH did not varied by more than 1 unit ;
- The concentrations of the test substance have been maintained to within 80 % of the initial concentration throughout the duration of the test.

Reliability : (1) valid without restriction
Flag : Critical study for SIDS endpoint
06.01.2004 (4)

Type : other: ECOSAR Predicted LC50
Species : other: Daphnid
Exposure period : 48 hour(s)
Unit : mg/l
Analytical monitoring :
LC50 : c = 0.045
Method : other: calculated using EPIWIN v 3.10

Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	ECOSAR Program (v 0.99g). The following physical parameters were used: Molecular Weight: 124.2 Log Kow: 2.48 (KowWin estimate) Water Solubility: 178.9 mg/L (calculated)
Result	:	ECOSAR Class: Thiols (mercaptans) Organism: Daphnid Duration: 48-hr LC50: 0.045 mg/L (ppm)
Source	:	EPI Suite v 3.10.
Test substance	:	Benzenemethanethiol (CAS Number 100-53-8)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (14)

5.1.1 ACUTE ORAL TOXICITY

Type	:	LD50
Species	:	rat
Strain	:	Wistar
Sex	:	male
Number of animals	:	20
Vehicle	:	
Value	:	= 493 mg/kg bw
Method	:	other
Year	:	1957
GLP	:	no
Test substance	:	other TS

Method : Comparable to OECD 401 "Acute Oral Toxicity."

Result :

TIME OF DEATH
Cumulative mortality Following Administration by dose:
132 mg/kg: Day 1 = 0/5; Day 2 = 0/5; Day 3 = 0/5; Day 5 = 0/5; Day 10 = 0/5; Day 15 = 0/5

264 mg/kg: Day 1 = 0/5;Day 2 = 0/5; Day 3 = 0/5; Day 5 = 0/5; Day 10 = 0/5; Day 15 = 0/5

528 mg/kg: Day 1 = 0/5; Day 2 = 0/5; Day 3 = 0/5; Day 5 = 3/5; Day 10 = 3/5; Day 15 = 3/5

1056 mg/kg: Day 1 = 3/5; Day 2 = 5/5

2112 mg/kg: Day 1 = 5/5 (all dead 6-10 hrs)

CLINICAL SIGNS: From paragraph comparing several thiols tested by injection, stated to be similar results for oral:
- Compounds had property of being soporific, the degree ranging from mild stupor to heavy sedation.
- These conditions were slight for the aromatic thiols. - The response of the thiol-injected rats was fairly uniform in that the symptomology of acute poisoning developed in the order of: restlessness, increased respiration, incoordination, muscular weakness, skeletal muscle paralysis in most cases (starting with hind limbs), heavy to mild cyanosis, lethargy and/or sedation, respiratory depression followed by coma and death in cases of lethal doses.

LD50 1 day = 985 mg/kg (confidence limits 702-1383 mg/kg)
LD50 15 day = 493 mg/kg (confidence limits 351-692 mg/kg)

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test condition :

DOSES
132 mg/kg
264 mg/kg
528 mg/kg
1056 mg/kg

ORAL ADMINISTRATION
- Doses per Time Period: Single oral dose - undiluted.
- Each of the thiols was administered by gavage to at least four groups of

five rats each.
- Rats were dosed at levels in geometric progression (factor 1.26 or 2.0) by introducing measured amounts of the test material from a hypodermic syringe and blunted needle (8 cm, 18 gauge) which was passed through the esophagus into the stomach.

EXPERIMENTAL ANIMALS
- Rats were used of the same stock and weight.
- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.
STATISTICS
LD50 values were calculated by the method of Weil (1952).

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Test substance : alpha Toluenethiol (benzyl mercaptan) - Eastman Grade, 97% pure.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
31.12.2003 (8) (16)

5.1.2 ACUTE INHALATION TOXICITY

Type	:	LC50
Species	:	rat
Strain	:	Wistar
Sex	:	male
Number of animals	:	36
Vehicle	:	
Exposure time	:	4 hour(s)
Method	:	other
Year	:	1957
GLP	:	no
Test substance	:	other TS
Method	:	Comparable to OECD 403 " Acute Inhalation Toxicity".

Result : TIME OF DEATH
Cumulative Mortality During and After Exposure

58 ppm: 0-4 hr = 0/6; 24 hr = 0/6; 48 hr = 0/6; 15 day = 0/6

98 ppm: 0-4 hr = 0/6; 24 hr = 0/6; 48 hr = 0/6; 15 day = 0/6

130 ppm: 0-4 hr = 0/6; 24 hr = 0/6; 48 hr = 0/6; 15 day = 0/6

145 ppm: 0-4 hr = 0/6; 24 hr = 0/6; 48 hr = 0/6; 15 day = 0/6

185 ppm: 0-4 hr = 0/6; 24 hr = 0/6; 48 hr = 0/6; 15 day = 1/6*
* One died day 13 with pneumonia.

235 ppm: 0-4 hr = 0/6; 24 hr = 0/6; 48 hr = 0/6; 15 day = 1/6**
** One died day 7.

CLINICAL SIGNS : From paragraph comparing several thiols tested by inhalation:
- Maximal sublethal and lethal concentrations induced characteristic symptoms of toxicity, i.e. increased respiration and restlessness, incoordinated movement and staggering gait, muscular weakness, partial skeletal muscle paralysis beginning in the hind limbs, light to severe cyanosis, tolerance of prone position, and mild to heavy sedation.
- Fatal Responses usually followed one of two patterns:
(1) animals exposed to maximal lethal concentrations died from respiratory arrest while in or shortly after removal from the chamber, and
(2) those animals exposed to minimal lethal concentrations died while in a semiconscious condition of long duration. - The aromatic thiols induced some lethargy and sedation which was quickly terminated upon exposure to normal atmosphere.
- Most of the thiols were irritating to the mucus membranes within approximately 15 minutes after exposure to high concentrations as evidenced by their rubbing of the eyes and nose, eye closure, occasional sneezing, watering of the eyes, and retracting of the head.

LC50 Not Calculable -- Higher concentrations not used because of heavy condensation and other technical difficulties.

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test condition : alpha Toluenethiol (benzyl mercaptan) - Eastman Grade, 97% pure.

Test substance : DOSES
58 ppm
98 ppm
130 ppm
145 ppm
185 ppm
235 ppm

DOSE ADMINISTRATION
- Four hour exposure periods.
- The generation of thiol vapors was accomplished by either of two methods: (1) bubbling a stream of nitrogen gas (to prevent possible oxidation to sulfide) through a midget fritted-glass bubbler, which contained the liquid thiol, or (2) by passage of nitrogen into a borosilicate glass nebulizer which contained the thiol.
- Desired exposure concentrations of thiols were maintained in a glass chamber of approximately 18-liter capacity by varying the ratio of volume flow (liters/minute) of compressed air and compressed nitrogen.
- Prior to entering the chamber, the compressed air was scrubbed by passage through a fritted bubbler containing potassium dichromate in concentrated sulfuric acid, thence through a column of glass wool which was followed by a column of Drierite.
- From this it went into a mixing tube which received the thiol vapors by another inlet; the mixture then passed into the exposure chamber.

SAMPLING AND ANALYSIS OF EXPOSURE ATMOSPHERE
- During exposure periods the concentrations of thiols within the chamber were determined routinely by absorption of vapors in either iso-propyl alcohol or acetone containing an excess of silver nitrate and titrating the uncombined silver amperometrically according to the methods of Grimes, et al. (1955).
- Samples for analysis were collected in an Erlenmeyer flask containing an excess of silver nitrate of known normality (approximately 0.01 N) in 50 ml

of acetone or isopropyl alcohol; the choice of solvent was determined by the thiol used and its solubility therein.
- After the thiol vapors had been metered through this solution, the resulting precipitate (silver mercaptide) and other contents were quantitatively washed from the flask and the excess silver titrated amperometrically with standard dodecyl mercaptan (approximately 0.044 N).
- Accuracy of the sampling technique and analytical procedure as applied to this work was tested by vaporizing known amounts of thiols and was found to be within 2% of that calculated.

EXPERIMENTAL ANIMALS
- Six rats per dose group, averaging 200 +/- grams.
- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.
STATISTICS: LC50 values by inhalation were calculated by the method of Miller and Tainter (1944) using logarithmic-probit graph paper.

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
31.12.2003 (8) (9) (12)

Type : LC50
Species : mouse
Strain : Swiss
Sex : male
Number of animals : 60
Vehicle :
Exposure time : 4 hour(s)
Value : 178 ppm
Method : other
Year : 1957
GLP : no
Test substance : other TS

Method : Comparable to OECD 403 " Acute Inhalation Toxicity".

Result : TIME OF DEATH
Cumulative Mortality During and After Exposure
58 ppm: 0-4 hr = 0/10; 24 hr = 0/10; 48 hr = 0/10; 15 day = 0/10

98 ppm: 0-4 hr = 0/10; 24 hr = 0/10; 48 hr = 0/10; 15 day = 0/10

130 ppm: 1-4 hr = 0/10; 24 hr = 0/10; 48 hr = 0/10; 15 day = 0/10

145 ppm: 0-4 hr = 0/10; 24 hr = 0/10; 48 hr = 0/10; 15 day = 0/10

185 ppm: 1-4 hr = 3/10; 24 hr = 3/10; 48 hr = 3/10; 15 day = 6/10*
* One died day 3, two died day 4.

235 ppm: 0-4 hr = 1/10; 24 hr = 10/10

CLINICAL SIGNS : From paragraph comparing several thiols tested by inhalation:
- Maximal sublethal and lethal concentrations induced characteristic symptoms of toxicity, i.e. increased respiration and restlessness (hyperactivity in mice), incoordinated movement and staggering gait, muscular weakness, partial skeletal muscle paralysis beginning in the hind limbs, light to severe cyanosis, tolerance of prone position, and mild to heavy sedation.
- Fatal Responses usually followed one of two patterns:
(1) animals exposed to maximal lethal concentrations died from respiratory arrest while in or shortly after removal from the chamber, and
(2) those animals exposed to minimal lethal concentrations died while in a semiconscious condition of long duration. - The aromatic thiols induced some lethargy and sedation which was quickly terminated upon exposure to normal atmosphere.
- Most of the thiols were irritating to the mucus membranes within approximately 15 minutes after exposure to high concentrations as evidenced by their rubbing of the eyes and nose, eye closure, occasional sneezing, watering of the eyes, and retracting of the head.

LC50 24 hr: 195 ppm (est)
LC50 15 day: 178 ppm (est)

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test condition : alpha Toluenethiol (benzyl mercaptan) - Eastman Grade, 97% pure.

Test substance : DOSES
58 ppm
98 ppm
130 ppm
145 ppm
185 ppm
235 ppm

DOSE ADMINISTRATION
- Four hour exposure periods.
- The generation of thiol vapors was accomplished by either of two methods: (1) bubbling a stream of nitrogen gas (to prevent possible oxidation to sulfide) through a midget fritted-glass bubbler, which contained the liquid thiol, or (2) by passage of nitrogen into a borosilicate glass nebulizer which contained the thiol.
- Desired exposure concentrations of thiols were maintained in a glass chamber of approximately 18-liter capacity by varying the ratio of volume flow (liters/minute) of compressed air and compressed nitrogen.
- Prior to entering the chamber, the compressed air was scrubbed by passage through a fritted bubbler containing potassium dichromate in concentrated sulfuric acid, thence through a column of glass wool which was followed by a column of Drierite.
- From this it went into a mixing tube which received the thiol vapors by another inlet; the mixture then passed into the exposure chamber.

SAMPLING AND ANALYSIS OF EXPOSURE ATMOSPHERE
- During exposure periods the concentrations of thiols within the chamber were determined routinely by absorption of vapors in either iso-propyl alcohol or acetone containing an excess of silver nitrate and titrating the uncombined silver amperometrically according to the methods of Grimes, et al. (1955).
- Samples for analysis were collected in an Erlenmeyer flask containing an excess of silver nitrate of known normality (approximately 0.01 N) in 50 ml

of acetone or isopropyl alcohol; the choice of solvent was determined by the thiol used and its solubility therein.
- After the thiol vapors had been metered through this solution, the resulting precipitate (silver mercaptide) and other contents were quantitatively washed from the flask and the excess silver titrated amperometrically with standard dodecyl mercaptan (approximately 0.044 N).
- Accuracy of the sampling technique and analytical procedure as applied to this work was tested by vaporizing known amounts of thiols and was found to be within 2% of that calculated.

EXPERIMENTAL ANIMALS
- Ten mice per dose group, averaging 25 to 28 grams.
- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.
STATISTICS: LC50 values by inhalation were calculated by the method of Miller and Tainter (1944) using logarithmic-probit graph paper.

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
31.12.2003 (8) (9) (12)

5.1.3 ACUTE DERMAL TOXICITY

Type	:	LD0
Species	:	rat
Strain	:	Sprague-Dawley
Sex	:	male/female
Number of animals	:	10
Vehicle	:	
Value	:	>= 2000 mg/kg bw
Method	:	OECD Guide-line 402 "Acute dermal Toxicity"
Year	:	1995
GLP	:	yes
Test substance	:	other TS

Result : MORTALITY: No death occurred at 2000 mg/kg.

CLINICAL SIGNS
- No clinical signs and no cutaneous reactions were observed during the study.
- General behavior and body weight was not affected.

PATHOLOGY: Macroscopic examination of the main organs of the animals revealed no apparent abnormalities.

Dermal LD0 of the test substance was higher than or equal to 2000 mg/kg in rats. (author)

Source : Elf Atochem Rotterdam B.V., Acute Dermal Toxicity in Rats - Benzyl

Mercaptan. Study performed by Centre International de Toxicologie (C.I.T.), Miserey, France.

Test condition : The test substance was applied in its original form to the dorsal area skin (10% surface area) of one group of ten Sprague-Dawley rats (five males and five females) at a dose of 2000 mg/kg. The test site was then covered by semi-occlusive dressing for 24 hours.

Clinical signs, mortality and body weight gain were checked for a period of 14 days following the single administration of the test substance.

All animals were subjected to necropsy.

TEST ANIMALS
- Rat, Sprague-Dawley ICO: OFA-SD (IOPS Caw).
- Age/weight: on the day of treatment, the animals were approximately eight weeks old, and had a mean body weight +/- standard deviation of 272 +/- 5 g for the males and 228 +/- 17 g for the females.
- Acclimatization: at least five days before the beginning of the study.

ENVIRONMENTAL CONDITIONS
- Temperature: 21 +/- 2 deg C
- Relative humidity: 30 to 70 percent
- Light/dark cycle: 12 h/12 h
- Ventilation: about 12 cycles/h of filtered, non-recycled air.
- The animals were housed in polycarbonate cages.
- The animals were housed individually during the treatment.

CLINICAL EXAMINATIONS
- The animals were observed frequently during the hours following administration of the test substance, for detection of possible treatment-related clinical signs.
- Thereafter, observation of the animals was made at least once a day.
- Type, time of onset and duration of clinical signs and local cutaneous reactions were recorded for each animal individually.
- Body weight: animals were weighed individually just before administration of the test substance on day 1 and then on days 8 and 15.

NECROPSY
- On day 15, all animals were killed by CO2 inhalation in excess and a macroscopic examination was performed.
- After opening the thoracic and abdominal cavities, a macroscopic examination of the main organs (digestive tract, heart, kidneys, liver, lungs, pancreas, spleen, and any other organs with obvious abnormalities) was performed.
- In case of macroscopic lesions, organ samples were taken and preserved in 10% buffered formalin.
- No microscopic examination was performed.

Test substance : Benzyl mercaptan (CAS Number 100-53-8) supplied by Elf Atochem S.A. 99.3% pure (sample contained 0.04% Dibenzylsulphide and 0.13% Dibenzyldisulphide).

Reliability : (1) valid without restriction
Flag : Critical study for SIDS endpoint
31.12.2003 (5)

5.1.4 ACUTE TOXICITY, OTHER ROUTES

Type	:	LD50
Species	:	rat
Strain	:	Wistar
Sex	:	male
Number of animals	:	20
Vehicle	:	
Route of admin.	:	i.p.
Exposure time	:	unspecified
Value	:	= 373 mg/kg bw
Method	:	Intraperitoneal LD50
Year	:	1957
GLP	:	no
Test substance	:	other TS

Result :

TIME OF DEATH
Cumulative Mortality Following Administration
132 mg/kg: Day 1 = 0/5; Day 2 = 0/5; Day 3 = 0/5; Day 5 = 0/5; Day 10 = 0/5; Day 15 = 0/5

264 mg/kg: Day 1 = 0/5; Day 2 = 0/5; Day 3 = 0/5; Day 5 = 0/5; Day 10 = 1/5; Day 15 = 1/5

529 mg/kg: Day 1 = 4/5; Day 2 = 4/5; Day 3 = 4/5; Day 5 = 4/5; Day 10 = 4/5; Day 15 = 4/5

1058 mg/kg: Day 1 = 5/5 (All dead at 7 hrs.)

CLINICAL SIGNS : From paragraph comparing several thiols tested by injection:
- Compounds had property of being soporific, the degree ranging from mild stupor to heavy sedation. These conditions were slight for the aromatic thiols.
- The response of the thiol-injected rats was fairly uniform in that the symptomology of acute poisoning developed in the order of: restlessness, increased respiration, incoordination, muscular weakness, skeletal muscle paralysis in most cases (starting with hind limbs), heavy to mild cyanosis, lethargy and/or sedation, respiratory depression followed by coma and death in cases of lethal doses.

The LD50 1 Day (ip) = 429 mg/kg (confidence limits 325 - 566 mg/kg).
The LD50 15 Day (ip) = 373 mg/kg (confidence limit 252 - 553 mg/kg).

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test condition :

DOSES
132 mg/kg
264 mg/kg
529 mg/kg
1058 mg/kg

Dose ADMINISTRATION
- Doses per Time Period: Single intraperitoneal - undiluted.
- Groups of at least five Wistar-derived rats, each weighing on the average 200 +/- 20 grams were injected intraperitoneally at dosage levels differing by a factor of either 1.26 or 2.0 in a geometric series, according to Weil (1952).

EXPERIMENTAL ANIMALS
- Rats were used of the same stock and weight.
- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.
STATISTICS
LD50 values were calculated by the method of Weil (1952).

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Test substance : alpha Toluenethiol (benzyl mercaptan) - Eastman Grade, 97% pure.

Reliability : (2) valid with restrictions
31.12.2003 (8) (16)

5.2.1 SKIN IRRITATION

Species	:	rabbit
Concentration	:	undiluted
Exposure	:	Semiocclusive
Exposure time	:	4 hour(s)
Number of animals	:	3
PDII	:	
Result	:	not irritating
EC classification	:	not irritating
Method	:	OECD Guide-line 404 "Acute Dermal Irritation/Corrosion"
Year	:	1996
GLP	:	yes
Test substance	:	other TS

Result : Mean scores over 24, 48, and 72 hours for individual animal were 2.0, 1.7, and 1.0 for erythema and 1.3, 0.0, and 0.0 for edema.

- In one animal, very slight erythema was observed from day 2 up to day 5.
- In another rabbit, slight erythema was noted from day 2 up to day 5. It was accompanied with a slight oedema on days 2 and 3.
- In the third rabbit, very slight to slight erythema was observed up to day 8.
- Dryness of the skin was noted in all animals from day 3 or 4 up to day 8 (two animals) or until the end of the study (day 15, one animal).

Source : Elf Atochem Rotterdam B.V., Acute Dermal Irritation in Rabbits - Benzyl Mercaptan. Study performed by Centre International de Toxicologie (C.I.T.), Miserey, France.

Test condition : CONCENTRATION: The test substance was administered in its original form (undiluted).

TEST ANIMALS
- Male New Zealand White rabbits.
- Weight: on the day of treatment, the animals had a mean body weight +/- standard deviation of 2.6 +/- 0.2 kg.
- Acclimatization: at least five days before the beginning of the study.

ENVIRONMENTAL CONDITIONS
- Temperature: 18 +/- 3 deg C
- Relative humidity: 30 to 70 percent
- Light/dark cycle: 12 h/12 h
- Ventilation: about 12 cycles/h of filtered, non-recycled air.
- The animals were housed in polystyrene cages.
- The animals were housed individually during the treatment.

TREATMENT
- The day before treatment, the flanks of each animal were clipped using electric clippers.
- The skin was examined in order to use only animals without any signs of cutaneous irritation.
- A single dose of 0.5 ml of the test substance was applied to a 6 cm2 dry gauze pad which was then applied to the right flank of the animals for four hours.
- The test substance and the gauze pad were held in contact with the skin by means of an adhesive hypoallergenic aerated semi-occlusive dressing and a restraining bandage.
- No residual test substance was noted at removal of the dressing.

CONTROLS: The untreated skin served as control.

CUTANEOUS EXAMINATIONS
- The skin was examined approximately one hour, 24, 48, and 72 hours after removal of the dressing.
- Any change in the animals' behaviour was noted.

Scoring:
- Dermal irritation was evaluated for each animal according to the following scoring scale:

Erythema and eschar formation:
- No erythema --> 0
- Very slight erythema (barely perceptible) --> 1
- Well-defined erythema --> 2
- Moderate to severe erythema --> 3
- Severe erythema (beet redness) to slight eschar formation (injuries in depth) --> 4

Edema formation
- No edema --> 0
- Very slight edema (barely perceptible) --> 1
- Slight edema (edges of area well-defined by definite raising) --> 2
- Moderate edema (raised approximately 1 mm) --> 3
- Severe edema (raised more than 1 mm and extending beyond area of exposure) --> 4

Test substance : Benzyl mercaptan (CAS Number 100-53-8) supplied by Elf Atochem S.A. 99.3% pure (sample contained 0.04% Dibenzylsulphide and 0.13% Dibenzyldisulphide).

Reliability : (1) valid without restriction
31.12.2003 (6)

5.3 SENSITIZATION

Type : Guinea pig maximization test
Species : guinea pig

Concentration	:	Induction 10 % active substance intracutaneous Induction undiluted occlusive epicutaneous Challenge undiluted occlusive epicutaneous
Number of animals	:	30
Vehicle	:	other: paraffin oil
Result	:	not sensitizing
Classification	:	not sensitizing
Method	:	OECD Guide-line 406 "Skin Sensitization"
Year	:	1996
GLP	:	yes
Test substance	:	other TS

Result :

Conclusion: Under experimental conditions and according to the maximization method of Magnusson and Kligman (1969), no cutaneous reactions attributable to the sensitization potential of Benzyl Mercaptan were observed in guinea pigs.

- No clinical signs and no treatment-related deaths were noted during the study.
- After the challenge application, comparable slight to severe skin reactions were observed in the treated and control groups. Based on clinical observation, differentiation between an irritant effect of the test substance and a sensitization effect could not be made since the skin reactions were present in the control group at approximately the same level of severity.
- Due to the severity of the skin damage observed, a second challenge application was considered unethical.
- The animals were killed and microscopic examination of skin samples was performed: the morphological characteristics and the severity of the microscopic findings found in the skin of the treated or control animals were comparatively similar. The major findings were degeneration/necrosis of epidermis and inflammatory cell infiltration, mainly of granulocytes, together with exocytosis and exudation somtimes in lacunae.
- The above-mentioned findings are those expected in cases of skin irritation.

Positive Control: The guinea-pigs which were used in a recent study, showed a satisfactory sensitization response in 100% of the animals using a positive sensitizer (2,4-dinitro chlorobenzene).

RESULTS FOR INDIVIDUAL ANIMALS:
Results presented as: Erythema LF / Erythema RF / Edema LF / Edema RF
(Abbreviations: LF = left flank (control); RF = right flank (treated); A = crusts; S = dryness of the skin; DT = tissular destruction; P = pallor of the skin; "-" = dead animal.)

Treated Group 2 - Males #06 through #15,
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0 / 0 / 0 72 hrs: 0 / 0 / 0 / 0
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0 / 0 / 0 72 hrs: 0 / 0 / 0 / 0
24 hrs: 0 / 0,P / 0 / 4 48 hrs: 0 / 1,P / 0 / 2 72 hrs: 0 / 1,P / 0 / 2
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0 / 0 / 0 72 hrs: 0 / 0 / 0 / 0
24 hrs: 0 / 0,P / 0 / 4 48 hrs: 0 / 1,P / 0 / 2 72 hrs: 0 / 1,P / 0 / 2
24 hrs: 0 / 1 / 0 / 0 48 hrs: 0 / 1,S / 0 / 0 72 hrs: 0 / 1,S / 0 / 0
24 hrs: 0 / 0,A / 0 / 0 48 hrs: 0 / DT,A / 0 / 0 72 hrs: 0 / DT,A / 0 / 0
24 hrs: 0,S / 0,S / 0 / 0 48 hrs: 0,S / 0,S / 0 / 0 72 hrs: 0,S / 0,S / 0 / 0
24 hrs, 48 hrs, and 72 hrs: - / - / - / -
24 hrs: 0 / 0,S / 0 / 0 48 hrs: 0 / 0 / 0 / 0 / 72 hrs: 0 / 0 / 0 / 0

Treated Group 2 - Females #21 through #30,
24 hrs: 0 / 0,S,A / 0 / 0 48 hrs: 0 / 1,S,A / 0 / 2 72 hrs: 0 / 1,S / 0 / 0
24 hrs: 0 / 0,P / 0 / 0 48 hrs: 0 / 2,P / 0 / 4 72 hrs: 0 / 2,P / 0 / 4
24 hrs: 0,S / 0,S / 0 / 0 48 hrs: 0,S / 0,S / 0 / 0 72 hrs: 0 / 0,S / 0 / 0

24 hrs: 0 / 1 / 0 / 0 48 hrs: 0 / 0,S / 0 / 0 72 hrs: 0 / 0,S / 0 / 0
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0,S / 0 / 0 72 hrs: 0 / 0,S / 0 / 0
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / DT,A / 0 / 2 72 hrs: 0 / A / 0 / 2
24 hrs: 0 / 0,A / 0 / 0 48 hrs: 0 / 4,S,A / 0 / 2 72 hrs: 0 / 3,S,A / 0 / 2
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0 / 0 / 0 72 hrs: 0 / 0 / 0 / 0
24 hrs: 0 / 1,S / 0 / 0 48 hrs: 0 / 4,A / 0 / 2 / 72 hrs: 0 / 3,A / 0 / 2
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0,S / 0 / 0 / 72 hrs: 0 / 0,S / 0 / 0

Control Group 1 - Males #01 through #05,
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 1 / 0 / 2 72 hrs: 0 / 2 / 0 / 0
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0 / 0 / 0 72 hrs: 0 / 0 / 0 / 0
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 1,S / 0 / 2 72 hrs: 0 / 1,S / 0 / 2
24 hrs: 0 / 0,P / 0 / 4 48 hrs: 0 / 4 / 0 / 2 72 hrs: 0 / 0,P / 0 / 4
24 hrs: 0 / 1 / 0 / 0 48 hrs: 0 / 1 / 0 / 0 72 hrs: 0 / 1 / 0 / 0

Control Group 1 - Females #16 through #20,
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 1,S / 0 / 0 72 hrs: 0 / 0 / 0 / 0
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0,S / 0 / 0 72 hrs: 0 / 0 / 0 / 0
24 hrs: 0 / 0,P / 0 / 4 48 hrs: 0 / 0,P,A / 0 / 4 72 hrs: 0 / 0,P,A / 0 / 2
24 hrs: 0 / 0 / 0 / 0 48 hrs: 0 / 0 / 0 / 0 72 hrs: 0 / 0 / 0 / 0
24 hrs: 0 / 1 / 0 / 0 48 hrs: 0 / 0 / 0 / 0 72 hrs: 0 / 0 / 0 / 0

Source : Elf Atochem Rotterdam B.V., Skin Sensitization Test in Guinea-Pigs (Maximization method of Magnusson, B. and Kligman, A.M.) - Benzyl Mercaptan. Study performed by Centre International de Toxicologie (C.I.T.), Miserey, France.

Test condition : TEST ANIMALS
- Species and Strain: Dunkin-Hartley guinea-pigs (15 males and 15 nulliparous and non-pregnant females).
- Age and Weight: on day 1, the animals were approximately three months old and had a mean body weight +/- standard deviation of 312 +/- 16 g for the males and 352 +/- 29 g for the females.
- Acclimatization: at least five days before the beginning of the study.

ENVIRONMENTAL CONDITIONS
- Temperature: 21 +/- 2 deg C
- Relative humidity: 30 to 70 percent
- Light/dark cycle: 12 h/12 h
- Ventilation: about 12 cycles/h of filtered, non-recycled air.
- The animals were housed in polycarbonate cages with dust-free sawdust provided as litter.
- The animals were housed individually during the treatment.

METHODS
-Thirty guinea-pigs were allocated to two groups: a control group 1 (five males and five females) and a treated group 2 (ten males and ten females).
- On day 1, in the dorsal region between the shoulders, intradermal injections of Freund's complete adjuvant mixed with the test substance (treated group) or the vehicle (control group) were prepared.
- On day 7, the same region received a topical application of sodium laurylsulfate in vaseline (10% w/w) in order to induce local irritation.
- On day 8, this same test site was treated by topical application of the test substance (treated group) or the vehicle (control group) and was covered by an occlusive dressing for 48 hours.
- After a rest period of 12 days, all animals of the treated and control groups were challenged by a topical application of the test substance to the right flank. The left flank served as control and received the vehicle only.
- Test substance and vehicle were maintained under an occlusive dressing for 24 hours.

Test Substance Concentrations:

- Induction (treated group)
--- Intradermal injections: Benzyl Mercaptan at 10% (w/w) in paraffin oil
--- Topical application: Benzyl Mercaptan undiluted.

- Challenge (all groups)
--- topical application: Benzyl Mercaptan undiluted.

CLINICAL AND MICROSCOPIC EXAMINATIONS
- Skin reactions were evaluated approximately 24, 48, and 72 hours later.
- At the end of the study, animals were killed and cutaneous samples were taken from the challenge application sites from all the animals. Histological examinations were performed on the samples of cutaneous tissue, on the right flank, from all the animals of the control and treated groups.

POSITIVE CONTROL
- The sensitivity of the guinea-pigs in C.I.T. experimental conditions were confirmed in a recent study with a positive sensitizer: 2,4-dinitro chlorobenzene. During induction period, the test substance was applied at 0.1% (day 1) and 1% (day 8) concentrations. At cutaneous challenge application, 1% (w/w) was tested on the right flank.

Test substance : Benzyl mercaptan (CAS Number 100-53-8) supplied by Elf Atochem S.A. 99.3% pure (sample contained 0.04% Dibenzylsulphide and 0.13% Dibenzyldisulphide).

Reliability : (1) valid without restriction
02.01.2004 (7) (11)

5.5 GENETIC TOXICITY 'IN VITRO'

Type	:	Bacterial reverse mutation assay
System of testing	:	Bacterial, Strains: TA1535, TA100, TA1537, TA1538, TA98.
Concentration	:	Not given
Cycotoxic conc.	:	
Metabolic activation	:	with and without
Result	:	negative
Method	:	other
Year	:	1982
GLP	:	no
Test substance	:	other TS

Method : Comparable to OECD 471 "Genetic Toxicology: Salmonella typhimurium, Reverse Mutation Assay."

Result : Negative

Statistical Results not given.

Source : Study of Artificial Flavouring Substances for Mutagenicity in the Salmonella/Microsome, BASC and Micronucleus Tests (Wild et al., 1983).

Test condition : Methods are general methods for several compounds studied

TEST DESIGN
- 5 doses in each strain, with and without activation.
- Standard plate procedure followed (Ames et al., 1975)
- Vogel-Bonner medium used throughout (Vogel & Bonner, 1956)
- Plates incubated for 48 hours.

NUMBER OF REPLICATES: Tested at least twice

POSITIVE AND NEGATIVE CONTROLS:
- Positive Controls: sodium azide, benzo[a]pyrene.
- Positive controls were run in each experiment.
- Over a period of 2 yr, the numbers of revertants/plate in positive controls were in the following ranges: with sodium azide, at 0.5 ug/plate, 430-760 in TA1535, 400-700 in TA100; with benzo[a]pyrene, at 5 ug/plate, 865-1210 in TA100, 235-350 in TA1537, 410-590 in TA1538, 660-1000 in TA98.

SOLVENT: Dimethylsulphoxide was used as solvent for test chemicals that were poorly soluble in water.

METABOLIC ACTIVATION
- S-9 liver fractions were prepared from Aroclor pre-treated rats (Aroclor 1254, 500 mg/kg ip) and adjusted to 25 mg protein/ml; 0.5 ml S-9 mix, equivalent to 50 µl S-9.

STATISTICAL METHODS
- Statistical significance was determined according to the methods of Kastenbaum & Bowman (1970).
- With regards to the Ames tests, results that met the following additional criteria were regarded as positive (+): a reproducible, dose-related and at least two-fold elevation of the spontaneous revertant frequency. Agents producing reproducible, dose-related and significant (P</= 0.01) but less than two-fold elevations were classified as marginally mutagenic under the experimental conditions.

Test substance : Benzylmercaptan (toluene-alpha-thiol) supplied by ICN-K&K, Plainview, NY. Purity not given.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
31.12.2003 (1) (10) (15) (17)

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(13) O'Neil, M.J. (ed.), 2001. The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals, 13th ed., Merck & Co., Inc., Whitehouse Station, NJ.

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(16) Weil, C.S., 1952. Tables for Convenient Calculation of Median-Effective Dose (LD50 or ED50) and Instructions in Their Use. Biometrics, 8:249-263.

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7.1 END POINT SUMMARY

7.2 HAZARD SUMMARY

7.3 RISK ASSESSMENT

Appendix II

Phenyl Mercaptan

I U C L I D

Data Set

Existing Chemical	:	ID: 108-98-5
CAS No.	:	108-98-5

Producer Related Part

Company	:	Chevron Phillips Chemical Company LP
Creation date	:	24.11.2003

Substance Related Part

Company	:	Chevron Phillips Chemical Company LP
Creation date	:	24.11.2003
Memo	:	
Printing date	:	02.01.2004
Revision date	:	
Date of last Update	:	02.01.2004
Number of Pages	:	4
Chapter (profile)	:	Chapter: 1, 2, 3, 4, 5, 7
Reliability (profile)	:	Reliability: without reliability, 1, 2, 3, 4
Flags (profile)	:	Flags: without flag, confidential, non confidential, WGK (DE), TA-Luft (DE), Material Safety Dataset, Risk Assessment, Directive 67/548/EEC, SIDS

1.0.1 OECD AND COMPANY INFORMATION

Type	:	other
Name	:	Chevron Phillips Chemical Company LP
Partner	:	
Date	:	
Street	:	10001 Six Pines Drive
Town	:	77380 The Woodlands, TX
Country	:	United States
Phone	:	
Telefax	:	
Telex	:	
Cedex	:	

24.11.2003

1.2 SYNONYMS

Benzenethiol
24.11.2003

Phenyl Mercaptan
24.11.2003

Thiophenol
24.11.2003

2.1 MELTING POINT

Value	:	= -14.9 ° C
Sublimation	:	
Method	:	other: no data
Year	:	
GLP	:	no data
Test substance	:	other TS
Source	:	CRC Handbook of Chemistry and Physics (Lide, D.R., 2001-2002, 82nd ed.)
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

24.11.2003 (15)

Value	:	= -14.9 ° C
Sublimation	:	
Method	:	other: EPIWIN v 3.10
Remarks		Selected Melting Point (calculated mean value) was -31.86 ºC.
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	MPBWIN (v 1.40) Program, Experimental Melting Point.
Source	:	EPI Suite v 3.10.
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5).
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (32)

Value	:	= -14.8 ° C
Sublimation	:	
Method	:	other: no data
Year	:	
GLP	:	no data
Test substance	:	other TS
Source	:	Patty's Toxicology (Bingham, E., 2001, 5th ed.)
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

24.11.2003 (4)

2.2 BOILING POINT

Value	:	= 168.7 ° C
Decomposition	:	
Method	:	other: no data
Year	:	
GLP	:	no data
Test substance	:	other TS
Source	:	Patty's Toxicology (Bingham, E., 2001, 5th ed.)
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

24.11.2003 (4)

Value	:	= 169.1 ° C at
Decomposition	:	

Method	:	other: no data
Year	:	
GLP	:	no data
Test substance	:	other TS
Source	:	CRC Handbook of Chemistry and Physics (Lide, D.R., 2001-2002, 82nd ed.)
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

24.11.2003 (15)

Value	:	= 169.1 ° C
Decomposition	:	
Method	:	other: EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	MPBWIN (v 1.40) Program, Experimental Boiling Point.
Remarks		The Boiling Point was calculated to be 176.14 ºC using the Adapted Stein & Brown Method.
Source	:	EPI Suite v 3.10.
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5).
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (32)

Value	:	= 169.5 ° C
Decomposition	:	
Method	:	other: no data
Year	:	
GLP	:	no data
Test substance	:	other TS
Source	:	Sax's Dangerous Properties of Industrial Materials (Lewis, 2000, 10th ed.)
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5), purity not given
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

24.11.2003 (14)

2.4 VAPOUR PRESSURE

Value	:	= 2.66645 hPa at 25° C
Decomposition	:	
Method		
Year	:	
GLP	:	no data
Test substance	:	other TS
Source	:	Patty's Toxicology (Bingham, E., 2001, 5th ed.)
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (4)

Value	:	= 2.57 hPa at 25° C
Decomposition	:	
Method		other (calculated): EPIWIN v 3.10
Remarks		The Selected Vapor Pressure was calculated to be 1.63 mmHg (2.17316 hPa) at 25 ºC using the mean of Antoine & Grain methods.
Year	:	2003
GLP	:	no
Test substance	:	other TS

Method : MPBWIN (v 1.40) Program, Experimental Vapor Pressure.
Source : EPI Suite v 3.10.
Test substance : Phenyl Mercaptan (CAS Number 108-98-5).
Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
05.12.2003 (32)

2.5 PARTITION COEFFICIENT

Log pow : = 2.52
Method other (calculated): no data
Year : 1989
GLP : no
Test substance : other TS
Source : Octanol-water partition coefficients of simple organic compounds (Sangster, 1989 in J Phys Chem Ref Data).
Test substance : Phenylmercaptan (Thiophenol) CAS Number 108-98-5, Purity not given.
Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
24.11.2003 (22)

Log pow : = 2.52
Method other (calculated): EPIWIN v 3.10
Remarks The estimated Log Kow was calculated to be 2.69.
Year : 2003
GLP : no
Test substance : other TS
Method : WSKOW v 1.40 - Experimental Log Kow.
Source : EPI Suite v 3.10.
Test substance : Phenyl Mercaptan (CAS Number 108-98-5)
Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
05.12.2003 (32)

2.6.1 WATER SOLUBILITY

Value : = 835 mg/l at 25 ° C
Qualitative : moderately soluble (100-1000 mg/L)
Pka :
PH :
Method : other: EPIWIN v 3.10
Remarks The estimated Water Solubility was calculated to be 765.5 mg/L at 25 ºC.
Year : 2003
GLP : no
Test substance : other TS
Method : WSKOW v 1.40 - Experimental Water Solubility.
Source : EPI Suite v 3.10.
Test substance : Phenyl Mercaptan (CAS Number 108-98-5).
Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
05.12.2003 (32)

Value : = 1
Qualitative :
Pka :
PH :
Method : other: no data
Year :

GLP	:	no data
Test substance	:	other TS
Result	:	Solubility in H2O = 1; Solubility in EtOh = 3
Source	:	CRC Handbook of Chemistry and Physics (Lide, D.R., 2001-2002, 82nd ed.)
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5)
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

31.12.2003 (15)

Value	:	
Qualitative	:	
Pka	:	6.62 at 25 ° C
PH	:	
Source	:	Ionisation Constants of Organic Acids in Aqueous Solution (Serjeant and Dempsey, 1979)
Test substance	:	Benzenethiol (Thiophenol), purity not noted
Flag	:	Critical study for SIDS endpoint

24.11.2003 (29)

3.1.1 PHOTODEGRADATION

Type	:	other
Light source	:	
Light spect.	:	
Rel. intensity	:	
Deg. Product	:	
Method	:	other (calculated): EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	AOP Program (v 1.90).
Result	:	Overall OH Rate Constant = 11.32 E-12 cm3/molecule-sec Half-Life = 0.945 Days (12-hr day; 1.5E6 OH/cm3) Half-Life = 11.34 Hrs
Source	:	EPI Suite v 3.10.
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5).
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (32)

3.3.1 TRANSPORT BETWEEN ENVIRONMENTAL COMPARTMENTS

Type	:	fugacity model level III
Media	:	other: air-water-soil-sediment
Air (level I)	:	
Water (level I)	:	
Soil (level I)	:	
Biota (level II / III)	:	
Soil (level II / III)	:	
Method	:	other: EPIWIN v 3.10
Year	:	2003
Method	:	Used EPIWIN v 3.10. The following physical properties were used as the model input parameters: Molecular Wt: 110.17 Henry's LC: 0.000335 atm-m3/mole (Henry experimental database) Vapor Pressure: 1.63 mm Hg (Mpbpwin program) Log KOW: 2.52 (Kowwin program) Soil Koc: 136 (calc by model)
Result	:	Results are provided in the following format: Compartment / 100% to Air / 100% to Water / 100% to Soil / Equally to Each Compartment Air / 94.4% / 3.43% / 1.01% / 5.37% Water / 4.58% / 96.0% / 1.61% / 34.2% Soil / 0.993% / 0.0361% / 97.4% / 60.3% Sediment / 0.025% / 0.523% / 0.0088% / 0.186% Air: half life = 22.92 hr; emissions = 1000 kg/hr

Water: half life = 360 hr; emissions = 1000 kg/hr
Soil: half life = 360 hr; emissions = 1000 kg/hr
Sediment: half life = 1.44E+3 hr; emissions = 0 kg/hr

Persistence when distributed equally to each compartment = 231 hr (Emissions (kg/hr) = 1000 to air, 1000 to water, 1000 to soil, and 0 to sediment)

Source : EPI Suite v 3.10.

Test substance : Phenyl Mercaptan (CAS Number 108-98-5).

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
05.12.2003 (32)

3.7 BIOACCUMULATION

BCF : = 17.39
Elimination :
Method : other: EPIWIN v 3.10
Year : 2003
GLP : no
Test substance : other TS

Method : BCF Program (v 2.14).

Remark : Estimated Log BCF = 1.240

Estimated Koc = 268 (using PCKOC Program (v 1.66)

Source : EPI Suite v 3.10.

Test substance : Phenyl Mercaptan (CAS Number 108-98-5).

Reliability : (2) valid with restrictions
05.12.2003 (32)

4.1 ACUTE/PROLONGED TOXICITY TO FISH

Type	:	other: ECOSAR Predicted LC50
Species	:	other: Fish
Exposure period	:	14 day
Unit	:	mg/l
Analytical monitoring	:	
LC50	:	c = 37.076
Method	:	other: calculated using EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS

Method : ECOSAR Program (v 0.99g).

The following physical parameters were used:
Molecular Weight: 110.17
Log Kow: 2.69 (KowWin estimate)
Water Solubility: 96.89 mg/L (calculated)

Result : ECOSAR Class: Neutral Organic SAR (Baseline Toxicity)
Organism: Fish
Duration: 14-day
LC50: 37.076 mg/L (ppm)

Source : EPI Suite v 3.10.

Test substance : Phenyl Mercaptan (CAS Number 108-98-5).

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
05.12.2003 (32)

Type	:	other: ECOSAR Predicted LC50
Species	:	other: Fish
Exposure period	:	96 hour(s)
Unit	:	mg/l
Analytical monitoring	:	
LC50	:	c = 6.082
Method	:	other: calculated using EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS

Method : ECOSAR Program (v 0.99g).

The following physical parameters were used:
Molecular Weight: 110.17
Log Kow: 2.69 (KowWin estimate)
Water Solubility: 96.89 mg/L (calculated)

Result : ECOSAR Class: Phenols
Organism: Fish
Duration: 96-hr
LC50: 6.082 mg/L (ppm)

Source : EPI Suite v 3.10.

Test substance : Phenyl Mercaptan (CAS Number 108-98-5).

Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (32)

4.2 ACUTE TOXICITY TO AQUATIC INVERTEBRATES

Type	:	other: ECOSAR Predicted LC50
Species	:	other: Daphnid
Exposure period	:	48 hour(s)
Unit	:	
Analytical monitoring	:	
LC50	:	c = 3.097
Method	:	other: calculated using EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	ECOSAR Program (v 0.99g). The following physical parameters were used: Molecular Weight: 110.17 Log Kow: 2.69 (KowWin estimate) Water Solubility: 96.89 mg/L (calculated)
Result	:	ECOSAR Class: Phenols Organism: Daphnid Duration: 48-hr LC50: 3.097 mg/L (ppm)
Source	:	EPI Suite v 3.10.
Test substance	:	Phenyl Mercaptan (CAS Number 108-98-5).
Reliability	:	(2) valid with restrictions
Flag	:	Critical study for SIDS endpoint

05.12.2003 (32)

4.3 TOXICITY TO AQUATIC PLANTS E.G. ALGAE

Species	:	other algae
Endpoint	:	other: ECOSAR Predicted EC50
Exposure period	:	96 hour(s)
Unit	:	mg/l
Analytical monitoring	:	
EC50	:	c = 13.41
Method	:	other: calculated using EPIWIN v 3.10
Year	:	2003
GLP	:	no
Test substance	:	other TS
Method	:	ECOSAR Program (v 0.99g). The following physical parameters were used: Molecular Weight: 110.17 Log Kow: 2.69 (KowWin estimate) Water Solubility: 96.89 mg/L (calculated)
Result	:	ECOSAR Class: Phenols

Organism: Green Algae
Duration: 96-hr
EC50: 13.410 mg/L (ppm)

Source : EPI Suite v 3.10.

Test substance : Phenyl Mercaptan (CAS Number 108-98-5).

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
05.12.2003 (32)

5.1.1 ACUTE ORAL TOXICITY

Type	:	LD50
Species	:	rat
Strain	:	Wistar
Sex	:	male
Number of animals	:	20
Vehicle	:	other: Ethanol as 8% v/v solution
Value	:	= 46.2 mg/kg bw
Method	:	other
Year	:	1957
GLP	:	no
Test substance	:	other TS

Method : Comparable to OECD 401 "Acute Oral Toxicity."

Result :

TIME OF DEATH
Cumulative mortality Following Administration by dose:
21.6 mg/kg: Day 1 = 0/5; Day 2 = 0/5; Day 3 = 0/5; Day 5 = 0/5; Day 10 = 0/5; Day 15 = 0/5

43 mg/kg: Day 1 = 3/5; Day 2 = 3/5; Day 3 = 3/5; Day 5 = 3/5; Day 10 = 3/5; Day 15 = 3/5

86.2 mg/kg: Day 1 = 4/5; Day 2 = 4/5; Day 3 = 4/5; Day 5 = 4/5; Day 10 = 4/5; Day 15 = 4/5

172.5 mg/kg: Day 1 = 5/5 (All dead at 5 hrs).

CLINICAL SIGNS: From paragraph comparing several thiols tested by injection, stated to be similar results for oral:
- Compounds had property of being soporific, the degree ranging from mild stupor to heavy sedation.
- These conditions were slight for the aromatic thiols. - The response of the thiol-injected rats was fairly uniform in that the symptomology of acute poisoning developed in the order of: restlessness, increased respiration, incoordination, muscular weakness, skeletal muscle paralysis in most cases (starting with hind limbs), heavy to mild cyanosis, lethargy and/or sedation, respiratory depression followed by coma and death in cases of lethal doses.

LD50 = 46.2 mg/kg (confidence limits 29.8 - 71.6 mg/kg)

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test condition :

DOSES
21.6 mg/kg
43.0 mg/kg
86.2 mg/kg
172.5 mg/kg

ORAL ADMINISTRATION
- Doses per Time Period: Single oral dose in Ethanol as 8% v/v solution.
- Each of the thiols was administered by gavage to at least four groups of five rats each.
- Rats were dosed at levels in geometric progression (factor 1.26 or 2.0) by introducing measured amounts of the test material from a hypodermic

syringe and blunted needle (8 cm, 18 gauge) which was passed through the esophagus into the stomach.

EXPERIMENTAL ANIMALS
- Rats were used of the same stock and weight.
- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.
STATISTICS
LD50 values were calculated by the method of Weil (1952).

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Test substance : Benzenethiol (phenyl mercaptan), highest purity Eastman Grade.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
31.12.2003 (10) (33)

5.1.2 ACUTE INHALATION TOXICITY

Type	:	LC50
Species	:	rat
Strain	:	Wistar
Sex	:	male
Number of animals	:	46
Vehicle	:	
Exposure time	:	4 hour(s)
Value	:	= 33 ppm
Method	:	other
Year	:	1957
GLP	:	no
Test substance	:	other TS

Method : Comparable to OECD 403 " Acute Inhalation Toxicity".

Result : TIME OF DEATH
Cumulative Mortality During and After Exposure

20 ppm: 0-4 hr = 0/5; 24 hr = 0/5; 48 hr = 0/5; 15 day = 0/5

31 ppm: 0-4 hr = 0/10; 24 hr = 0/10; 48 hr = 0/10; 15 day = 5/10

41 ppm: 0-4 hr = 0/6; 24 hr = 0/6; 48 hr = 1/6; 15 day = 4/6

52 ppm: 0-4 hr = 0/5; 24 hr = 0/5; 48 hr = 2/5; 15 day = 5/5

79 ppm: 0-4 hr = 0/10; 24 hr = 1/10; 48 hr = 3/10; 15 day = 10/10*
* 7 deaths between days 3 and 8 - some pneumonia.

132 ppm: 0-4 hr = 10/10 (all dead in 3 hrs).

CLINICAL SIGNS : From paragraph comparing several thiols tested by

inhalation:
- Maximal sublethal and lethal concentrations induced characteristic symptoms of toxicity, i.e. increased respiration and restlessness, incoordinated movement and staggering gait, muscular weakness, partial skeletal muscle paralysis beginning in the hind limbs, light to severe cyanosis, tolerance of prone position, and mild to heavy sedation.
- Fatal Responses usually followed one of two patterns:
(1) animals exposed to maximal lethal concentrations died from respiratory arrest while in or shortly after removal from the chamber, and
(2) those animals exposed to minimal lethal concentrations died while in a semiconscious condition of long duration. - The aromatic thiols induced some lethargy and sedation which was quickly terminated upon exposure to normal atmosphere.
- Most of the thiols were irritating to the mucus membranes within approximately 15 minutes after exposure to high concentrations as evidenced by their rubbing of the eyes and nose, eye closure, occasional sneezing, watering of the eyes, and retracting of the head.

LC50 48 hour = 59 ppm (Confidence Limits 50.7 - 67.3 ppm)
LC50 15 day = 33 ppm (Confidence Limits 29.6 - 36.4 ppm)

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test substance : DOSES
20 ppm
31 ppm
41 ppm
52 ppm
79 ppm
132 ppm

DOSE ADMINISTRATION
- Four hour exposure periods.
- The generation of thiol vapors was accomplished by either of two methods: (1) bubbling a stream of nitrogen gas (to prevent possible oxidation to sulfide) through a midget fritted-glass bubbler, which contained the liquid thiol, or (2) by passage of nitrogen into a borosilicate glass nebulizer which contained the thiol.
- Desired exposure concentrations of thiols were maintained in a glass chamber of approximately 18-liter capacity by varying the ratio of volume flow (liters/minute) of compressed air and compressed nitrogen.
- Prior to entering the chamber, the compressed air was scrubbed by passage through a fritted bubbler containing potassium dichromate in concentrated sulfuric acid, thence through a column of glass wool which was followed by a column of Drierite.
- From this it went into a mixing tube which received the thiol vapors by another inlet; the mixture then passed into the exposure chamber.

SAMPLING AND ANALYSIS OF EXPOSURE ATMOSPHERE
- During exposure periods the concentrations of thiols within the chamber were determined routinely by absorption of vapors in either iso-propyl alcohol or acetone containing an excess of silver nitrate and titrating the uncombined silver amperometrically according to the methods of Grimes, et al. (1955).
- Samples for analysis were collected in an Erlenmeyer flask containing an excess of silver nitrate of known normality (approximately 0.01 N) in 50 ml of acetone or isopropyl alcohol; the choice of solvent was determined by the thiol used and its solubility therein.
- After the thiol vapors had been metered through this solution, the resulting precipitate (silver mercaptide) and other contents were

quantitatively washed from the flask and the excess silver titrated amperometrically with standard dodecyl mercaptan (approximately 0.044 N).
- Accuracy of the sampling technique and analytical procedure as applied to this work was tested by vaporizing known amounts of thiols and was found to be within 2% of that calculated.

EXPERIMENTAL ANIMALS
- Five to ten rats per dose group, averaging 200 +/- 20 grams.
- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.
STATISTICS: LC50 values by inhalation were calculated by the method of Miller and Tainter (1944) using logarithmic-probit graph paper.

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
31.12.2003 (10) (11) (16)

Type : LC50
Species : mouse
Strain : Swiss
Sex : male
Number of animals : 45
Vehicle :
Exposure time : 4 hour(s)
Value : = 28 ppm
Method : other
Year : 1957
GLP : no
Test substance : other TS

Method : Comparable to OECD 403 " Acute Inhalation Toxicity".

Result : TIME OF DEATH
Cumulative Mortality During and After Exposure

20 ppm: 0-4 hr = 0/10; 24 hr = 0/10; 48 hr = 0/10; 15 day = 0/10

31 ppm: 0-4 hr = 0/10; 24 hr = 0/10; 48 hr = 3/10; 15 day = 7/10*

41 ppm: 0-4 hr = 4/10; 24 hr = 7/10; 48 hr = 8/10; 15 day = 10/10*

52 ppm: 0-4 hr = 9/10; 24 hr = 10/10

79 ppm: 0-4 hr = 5/5 (2 hrs post exposure).

* 2 deaths from pulmonary infections - some pneumonia.

CLINICAL SIGNS : From paragraph comparing several thiols tested by inhalation:
- Maximal sublethal and lethal concentrations induced characteristic symptoms of toxicity, i.e. increased respiration and restlessness,

incoordinated movement and staggering gait, muscular weakness, partial skeletal muscle paralysis beginning in the hind limbs, light to severe cyanosis, tolerance of prone position, and mild to heavy sedation.
- Fatal Responses usually followed one of two patterns:
(1) animals exposed to maximal lethal concentrations died from respiratory arrest while in or shortly after removal from the chamber, and
(2) those animals exposed to minimal lethal concentrations died while in a semiconscious condition of long duration. - The aromatic thiols induced some lethargy and sedation which was quickly terminated upon exposure to normal atmosphere.
- Most of the thiols were irritating to the mucus membranes within approximately 15 minutes after exposure to high concentrations as evidenced by their rubbing of the eyes and nose, eye closure, occasional sneezing, watering of the eyes, and retracting of the head.
- Corneal opacities or cloudiness in the eyes often occurred in mice just prior to or after death from expousre to benzenethiol.

LC50 24 hour = 47 ppm (Confidence Limits 43.4 - 50.6 ppm)
LC50 48 hour = 35.5 ppm (Confidence Limits 32.4 - 38.6 ppm)
LC50 15 day = 28 ppm (Confidence Limits 24.8 - 31.2 ppm)

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test condition : Benzenethiol (phenyl mercaptan), highest purity Eastman Grade.

Test substance : DOSES
20 ppm
31 ppm
41 ppm
52 ppm
79 ppm

DOSE ADMINISTRATION
- Four hour exposure periods.
- The generation of thiol vapors was accomplished by either of two methods: (1) bubbling a stream of nitrogen gas (to prevent possible oxidation to sulfide) through a midget fritted-glass bubbler, which contained the liquid thiol, or (2) by passage of nitrogen into a borosilicate glass nebulizer which contained the thiol.
- Desired exposure concentrations of thiols were maintained in a glass chamber of approximately 18-liter capacity by varying the ratio of volume flow (liters/minute) of compressed air and compressed nitrogen.
- Prior to entering the chamber, the compressed air was scrubbed by passage through a fritted bubbler containing potassium dichromate in concentrated sulfuric acid, thence through a column of glass wool which was followed by a column of Drierite.
- From this it went into a mixing tube which received the thiol vapors by another inlet; the mixture then passed into the exposure chamber.

SAMPLING AND ANALYSIS OF EXPOSURE ATMOSPHERE
- During exposure periods the concentrations of thiols within the chamber were determined routinely by absorption of vapors in either iso-propyl alcohol or acetone containing an excess of silver nitrate and titrating the uncombined silver amperometrically according to the methods of Grimes, et al. (1955).
- Samples for analysis were collected in an Erlenmeyer flask containing an excess of silver nitrate of known normality (approximately 0.01 N) in 50 ml of acetone or isopropyl alcohol; the choice of solvent was determined by the thiol used and its solubility therein.
- After the thiol vapors had been metered through this solution, the

resulting precipitate (silver mercaptide) and other contents were quantitatively washed from the flask and the excess silver titrated amperometrically with standard dodecyl mercaptan (approximately 0.044 N).
- Accuracy of the sampling technique and analytical procedure as applied to this work was tested by vaporizing known amounts of thiols and was found to be within 2% of that calculated.

EXPERIMENTAL ANIMALS
- Ten mice (Swiss derived) per dose group, averaging 25 to 28 grams.
- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.
STATISTICS: LC50 values by inhalation were calculated by the method of Miller and Tainter (1944) using logarithmic-probit graph paper.

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
31.12.2003 (10) (11) (16)

5.1.3 ACUTE DERMAL TOXICITY

Type	:	LD50
Species	:	rat
Strain	:	Wistar
Sex	:	male
Number of animals	:	35
Vehicle	:	
Value	:	= 300 mg/kg bw
Method	:	other
Year	:	1957
GLP	:	no
Test substance	:	other TS

Method : Comparable to OECD 402 " Acute Dermal Toxicity".

Remark : Toxicity data for a limited number of rabbits (3 rabbits per dose, doses of 67 mg/kg, 134 mg/kg, and 269 mg/kg) was also provided. Rabbits were dosed using the same method on a 6 x 10 cm area of the upper midback. The following results were obtained:

Cumulative Mortality Following Single Cutaneous Application

67 mg/kg: 0-8 Hours = 0/3; 24 Hours = 0/3; 48 Hours = 0/3; 72 Hours = 0/3

134 mg/kg: 0-8 Hours = 0/3; 24 Hours = 0/3; 48 Hours = 1/3; 72 Hours = 2/3

269 mg/kg: 0-8 Hours = 3/3 (All dead in 4 hrs).

Estimated LD50 = 134 mg/kg.

Result : TIME OF DEATH
Cumulative Mortality Following Single Cutaneous Application

134 mg/kg: 0-2 Hours = 0/5; 2-4 Hours = 0/5; 4-8 Hours = 0/5;
8-16 Hours = 0/5; 72 Hours = 1/5

213 mg/kg: 0-2 Hours = 0/5; 2-4 Hours = 0/5; 4-8 Hours = 0/5;
8-16 Hours = 1/5; 72 Hours = 1/5

269 mg/kg: 0-2 Hours = 0/10; 2-4 Hours = 1/10; 4-8 Hours = 1/10;
8-16 Hours = 1/10; 72 Hours = 2/10

339 mg/kg: 0-2 Hours = 2/5; 2-4 Hours = 3/5; 4-8 Hours = 4/5;
8-16 Hours = 4/5; 72 Hours = 4/5

427 mg/kg: 0-2 Hours = 2/5; 2-4 Hours = 4/5; 4-8 Hours = 4/5;
8-16 Hours = 4/5; 72 Hours = 4/5

538 mg/kg: 0-2 Hours = 4/5; 2-4 Hours = 4/5; 4-8 Hours = 5/5

Benzenethiol was classified as moderately toxic by this route.

CLINICAL SIGNS
- Rats exhibited irritative responses characterized by "ground-pawing" movements and frequent attempts to scratch and bite their backs.
- Rats often displayed tremors followed by a convulsion of short duration prior to respiratory depression and coma.
- Produced an inflammatory reaction of the skin a few hours after application. The redness usually disappeared within 24 to 48 hours.
- Autopsies made on animals dying from acute doses of thiols adminstered percutaneously usually did not show significant gross or microscopic tissue changes.

The LD50 = 300 mg/kg (confidence limits 236 - 384 mg/kg).

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test condition : DOSES
67 mg/kg (rabbits only -- see Remarks)
134 mg/kg
213 mg/kg
269 mg/kg
339 mg/kg
427 mg/kg
538 mg/kg

PERCUTANEOUS APPLICATION
- Cutaneous LD50 values for rats, five groups of five each and one group of 10, were calculated from mortality data obtained by single application of undiluted compounds (dosage levels in geometric progression) to a clipped area of the animals' backs.
- In this method areas of approximately 3 cm2 of the upper midbacks of rats were clipped as close to the skin as possible, care being taken to avoid abrasions and cuts.
- Animals were then placed in individual retainers and measured amounts of materials were delivered dropwise upon the clipped areas of the skin, exercising care in restricting the entire dosage to these areas.

EXPERIMENTAL ANIMALS
- Rats were used of the same stock and weight.

- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.

STATISTICS
LD50 values were calculated by the method of Weil (1952).

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Test substance : Benzenethiol (phenyl mercaptan), highest purity Eastman Grade.

Reliability : (2) valid with restrictions
Flag : Critical study for SIDS endpoint
31.12.2003 (10)

5.1.4 ACUTE TOXICITY, OTHER ROUTES

Type	:	LD50
Species	:	rat
Strain	:	Wistar
Sex	:	male
Number of animals	:	25
Vehicle	:	other: Ethanol as 5% v/v solution
Route of admin.	:	i.p.
Exposure time	:	unspecified
Value	:	= 9.8 mg/kg bw
Method	:	LD50 by i.p. route of administration
Year	:	1957
GLP	:	no
Test substance	:	other TS

Result : TIME OF DEATH
Cumulative Mortality Following Administration
6.7 mg/kg: Day 1 = 0/5; Day 2 = 0/5; Day 3 = 0/5; Day 5 = 0/5; Day 10 = 0/5; Day 15 = 0/5

13.5 mg/kg: Day 1 = 0/5; Day 2 = 0/5; Day 3 = 0/5; Day 5 = 0/5; Day 10 = 2/5; Day 15 = 2/5

27.0 mg/kg: Day 1 = 3/5; Day 2 = 3/5; Day 3 = 3/5; Day 5 = 5/5 (one dead 6 hrs past 5 days)

54.0 mg/kg: Day 1 = 5/5 (All dead 1 hr 10 mins)

108.0 mg/kg: Day 1 = 5/5 (All dead 1 hr 5 mins)

CLINICAL SIGNS : From paragraph comparing several thiols tested by injection:
- Compounds had property of being soporific, the degree ranging from mild stupor to heavy sedation. These conditions were slight for the aromatic thiols.
- The response of the thiol-injected rats was fairly uniform in that the symptomology of acute poisoning developed in the order of: restlessness, increased respiration, incoordination, muscular weakness, skeletal muscle

paralysis in most cases (starting with hind limbs), heavy to mild cyanosis, lethargy and/or sedation, respiratory depression followed by coma and death in cases of lethal doses.

The LD50 1 Day (ip) = 25.2 mg/kg (confidence limits 17.9 - 35.4 mg/kg).
The LD50 15 Day (ip) = 9.8 mg/kg (confidence limit 7.0 - 13.7 mg/kg).

Source : Toxicologic Studies on Organic Sulfur Compounds. 1. Acute Toxicity of some Aliphatic and Aromatic Thiols (Mercaptans) -- (Fairchild and Stokinger, 1958).

Test condition : DOSES
6.7 mg/kg
13.5 mg/kg
27.0 mg/kg
54.0 mg/kg
108.0 mg/kg

Dose ADMINISTRATION
- Doses per Time Period: Single intraperitoneal - Ethanol as 5% v/v solution.
- Groups of at least five Wistar-derived rats, each weighing on the average 200 +/- 20 grams were injected intraperitoneally at dosage levels differing by a factor of either 1.26 or 2.0 in a geometric series, according to Weil (1952).

EXPERIMENTAL ANIMALS
- Rats were used of the same stock and weight.
- Routine sacrifice of rodents was accomplished by separation of the cervical vertebrae.
- Other than those previously designated for early sacrifice, all animals were kept at least two weeks following the study.
- Most animals were held for observation for a month prior to being either destroyed or sacrificed for the study.
- Tissue specimens were submitted for pathologic examination after having first been examined grossly and preserved in either buffered formalin or Zenker's fixative.
STATISTICS
LD50 values were calculated by the method of Weil (1952).

POST DOSE OBSERVATION PERIOD: minimum of two weeks, possibly one month.

Test substance : Benzenethiol (phenyl mercaptan), highest purity Eastman Grade.

Reliability : (2) valid with restrictions
31.12.2003 (10) (33)

5.8 TOXICITY TO REPRODUCTION

Type : One generation study
Species : rat
Sex : male/female
Strain : Sprague-Dawley
Route of admin. : gavage
Exposure period :
Frequency of treatment : Daily
Premating exposure period

Male	:	7 Days
Female	:	7 Days
Duration of test	:	
Doses	:	35 mg/kg/day (7 mg/ml); 18 mg/kg/day (3.6 mg/ml); 9 mg/kg/day (1.8 mg/ml)
Control group	:	yes, concurrent vehicle
Method	:	other
Year	:	1996
GLP	:	yes
Test substance	:	other TS
Method	:	Reproductive Assessment by Continuous Breeding (RACB) protocol. Comparable to OECD Guideline 415 "One-Generation Reproduction Toxicity Study."
Result	:	LOAEL males: = 9 mg/kg LOAEL Females/fetus: = 35 mg/kg (reproductive) REPRODUCTIVE TOXICANT: Male: yes, slight, based on an increased incidence of inhibited spermiation in all treated F1 males, and decreased epidiymal sperm motility in the 18 and 35 mg/kg F0 male. Female: yes (developmental) slight, based on decreased pup weights. BODY WEIGHTS: No major effects in the F0 or F1 litter data, However consistently decreased live pup weights at 35 mg/kg were observed in both the F0 and F1 generations. During the Task 2 continuous breeding phase, live pup weights were decreased by 4 and 5 % in the 9 and 35 mg/kg dose groups. It is unclear why the 9 mg/kg group was affected, no changes were observed at 18 mg/kg. During the Task 3 female crossover mating (naïve males mated with 35 mg/kg females), the live pup weight was decreased by 9%. No decreases in the live pup weight were noted during the Task 3 male crossover mating. During the final litter of Task 2, the live pup weight was decreased by 14-16% on PND 4 and 7 in the 35 mg/kg dose group with no differences observed on PND 1, 14, or 21. The live pup weight of the F2 generation was also decreased during Task 4: decreased by 9 and 12% in the 18 and 35 mg/kg dose groups respectively. No differences were observed in adult female body weight for either the F0 or F1 generations, adult body weight of F0 and F1 35 mg/kg males were consistently decreased. LIVER AND KIDNEY WEIGHTS (relative to body weight): Liver and kidneys were enlarged in a treatment related fashion in both F0 and F1 animals. At necropsy a treatment related increase in the incidence of enlarged, pale, soft, and/or pitted kidneys was observed in the F0 and F1 males. Microscopic examination of the liver and kidneys from F0 and F1 animals revealed treatment-related hepatic lesions. Males were more affected than females. Dose (mg/kg)/ % increase/ sex F0 Liver 9, 18, 35 / 20%, 3%5, 50% / male 9, 18, 35 / 11%, 18%, 36% / females F1 Liver 9, 18, 35 / 18%, 37%, 62% / male 9, 18, 35 / 14%, 17%, 43% / females F0 Kidney 9, 18, 35 / 30%, 53%, 104% / male 9, 18, 35 / 8%, 5%, 20% / females

F1 Kidney
9, 18, 35 / 52%, 67%, 163% / male
9, 18, 35 / 12%, 6%, 26% / females

SPERM PARAMETERS:
Subtle changes were observed in sperm parameters of both the F0 and F1 generations. Epididymal sperm motility was decreased by 6 and 5% in the 18 and 35 mg/kg F0 males. Epididymal sperm motility was slightly but not significantly decreased by 4% in the 35 mg/kg F1 males. Although not statistically significant, epididymal sperm velocity was slightly decreased in the low (6%), middle (8%), and high (6%) F0 dose groups and in the high (7%) F1 dose group.
The weight of the right testis was increased by 11, 19, and 14 % in the 9, 18, and 35 mg/kg F1 males. Inhibited spermiation of the stage VIII-X tubules was observed in the 9 (6/10), 18 (6/10), and 35 (9/10) mg/kg F1 males.

CONCLUSIONS:
Results of this study have demonstrated that thiophenol is a slight female/developmental toxicant in Sprague-Dawley rats when administered in corn oil at 35 mg/kg based on decreased live pup weight during the crossover mating. Thiophenol was also determined to be a slight male reproductive toxicant at = 9 mg/kg based on an increased incidence of inhibited spermiation in all treated F1 males, and decreased epididymal sperm motility in the 18 and 35 mg/kg F0 males. Thiophenol is not a selective reproductive toxicant, since reproductive changes were seen only concomitant with significant hepatic and renal toxicity. (author)

Source : National Toxicology Program, 1996.

Test condition : Species/Strain:Rat/ Sprague-Dawley

Route of Administration: Oral (gavage)
Doses/Concentration Level:
- 35 mg/kg/day (7 mg/ml)
- 18 mg/kg/day (3.6 mg/ml)
- 9 mg/kg/day (1.8 mg/ml)

Control Group and treatment: Yes, corn oil gavage

Frequency of Treatment: daily until the day before euthanasia

Premating exposure (male and female): 7 days

Statistical Methods:
- Data from Tasks 2, 3, and 4 were statistically analyzed by Analytical Sciences Inc. (Durham, North Carolina). Most hypotheses were tested using the nonparametric multiple comparisons procedure of Dunn (1964) or Shirley (1977), as modified by Williams (1986). Shirley's test was designed to detect treatment related differences when the response to treatment consistently increased (or decreased) with increasing dose. Although the test employed a smoothing alogrithm to adjust for dose-response inversions, Dunn's test was more appropriate if the departure from monotonicity was severe. Jonckheere's test (1954) was used to ascertain whether there was sufficient evidence of a dose-related response to apply Shirley's test. If the p-value from Jonckheere's test was less than 0.01, Shirley's test was used; otherwise, Dunn's test was applied.
- In the crossover mating trial (Task 3), the Kruskal-Wallis test (Kruskal-Wallis, 1952) was used to test equality of response among dose groups, while multiple comparison tests used the method of Dunn.
- For data expressed as a proportion, the Cochran-Armitage test (Armitage, 1971) was used to test for a dose-related trend, and pairwise comparisons

were performed using a chi-square test (Conover, 1971).
- A parametric analysis of covariance (Neter and Wasserman, 1974) was used to test overall equality in average pup weight, after adjustment for average litter size. Pairwise comparisons were performed using Dunnett's test (1955).
- Vaginal cytology data were analyzed using a multivariate analysis of variance (Morrison, 1976) to test for the simultaneous equality of measurements across dose levels. Before applying the test, an arcsine transformation was performed to bring the data into closer conformance with normality assumptions.
- All findings reported as "increased" or "decreased" were statistically significant as compared to the control group.

STUDY DESIGN:

Task 1: Dose range-finding phase (not conducted sufficient data was available to select dose)
Task 2: F0 generation continuous breeding
Task 3: F0 male and female crossover breeding with untreated animals (control and high dose groups)
Task 4: F1 fertility assessment

Test Animals:
- Animals were approximately 11 weeks of age at the initiation of dosing and the body weight range of the animals was:
--- Task 2: 288.2-423.5 g for males and 214.0-287.4 g for females.
--- Task 3: 342.2-426.5g naïve males, 229.5-270.6 g naïve females

Test Design (vehicle, dosing schedules, pre& post observation):
- Vehicle: corn oil
- Task 2, 3: 20 animals/sex/group

Mating Procedures:
- Task 2: Continuous Breeding Phase: Following seven days of premating exposure to thiophenol by oral gavage, the animals were housed as breeding pairs for 112 days (16 weeks). Litters produced during the cohabitation were counted and weighed by sex on PND 1 and then euthanized. At the end of 112 days, the pairs were separated with continued dosing. Any litters born (F1) after the continuous breeding phase were reared by the dam until weaning on PND 21. Selected weanlings were raised in same sex groups until 81 +/- 10 days of age. F1 animals were dosed, after weaning, with the same level their parents received. These F1 animals were used for assessment of second-generation reproductive toxicity.

- Task 3: Because decreased pup weights were seen during Task 2, a one week crossover mating trial was performed on the parental animals from the control and the high dose groups to determine the affected sex. Low- and mid-dose animals were maintained at the same dosing regimen until the control and high dose animals were euthanized and necropsied. After Task 3 crossover mating, F0 animals were necropsied and terminal body weights and organ weights were obtained, sperm were analyzed, and reproductive tissues were saved.

- Task 4: Assessment of F1 generation, conducted using offspring from all 4 dose groups. At 81 +/- 10 days, twenty control animals of each sex and 20 treated animals in each dose group were randomly assigned to breeding pairs, avoiding sibling mating, and cohabitated for seven days then separated. Offspring were counted and weighed by sex on PND 1. At necropsy terminal body weight and organ weights were obtained, sperm analyzed, and reproductive tissues saved in fixative.

Test substance	:	Thiophenol (CAS No. 108-98-5, R.O.W. Sciences ID No. 1003) purchased for Aldrich Chemical Company (St. Louis, Missouri) and provided by the NTP through Research Triangle Institute. 101% pure (estimated by high performance liquid chromatography)
Reliability	:	(1) valid without restriction
Flag	:	Critical study for SIDS endpoint
02.01.2004		(3) (6) (7) (8) (12) (13) (17) (20) (21) (30) (36)

5.9 DEVELOPMENTAL TOXICITY/TERATOGENICITY

Species	:	rat
Sex	:	female
Strain	:	Sprague-Dawley
Route of admin.	:	gavage
Exposure period	:	Gestation Day 6 through 15
Frequency of treatment	:	Daily
Duration of test	:	Approximately 27 days (including 7 day quarantine before mating)
Doses	:	0, 20, 35, 50 mg/kg/day
Control group	:	yes, concurrent vehicle
NOAEL Teratogen	:	= 20 mg/kg bw
LOAEL Maternal Toxicity	:	= 20 mg/kg bw
Method	:	OECD Guide-line 414 "Teratogenicity"
Year	:	1994
GLP	:	yes
Test substance	:	other TS

Result :

Results presented in the following format:
Dose in mg/kg/day / Target Concentration in mg/ml / Replicate 1 Pre-Exposure Concentration as % of target / Replicate 2 Pre-Exposure Concentration as % of target
0 / 0 / <DL / <DL
20 / 4 / 98 / 99
35 / 7 / 91 / 100
50 / 10 / 108 / 104
DL-Detectable limit

MATERNAL DATA:
- LOAEL: 20 mg/kg/day
- NOAEL: Could not be determined based upon the doses evaluated in this study
- Based upon minor, transient decrease in maternal weight gain and food consumption on GD 6 to 9 at 35 mg/kg/day.
- Decrease in body weight and weight gain, decrease in food consumption during treatment period occurred at high dose level of 50 mg/kg/day.

FETAL DATA:
- NOAEL: 20 mg/kg/day
- Based upon reduced female fetal body weight observed at 35 mg/kg/day.
- Developmental toxicity observed as increased preimplantation death, decreased litter size, decreased fetal body weight, and increasing incidence of external malformations occurred at high dose.

MORTALITY
- 4 deaths in 50 mg/kg/day group
- One death on GD 10, two on GD 12, and one on GD 15.

PREGNANCY RATE

20 mg/kg/day: 100% (25/25)
35 mg/kg/day: 96% (24/25)
50 mg/kg/day: 100% (25/25)
Control: 100% (25/25)

DURATION OF PREGNANCY: dams sacrificed PND 20 (before delivery)

BODY WEIGHT: Maternal body weight was decreased in the high dose group on GD 9, 12, 15, 18, and 20. Maternal weight change was decreased in all treatment groups on GD 6 to 9, and in the high dose group on GD 9 to 12, 6 to 15 (treatment period), 0 to 20 (gestation period) and for corrected maternal weight gain.

FOOD/WATER CONSUMPTION:
- Absolute maternal food consumption was decreased in all treatment groups on GD 6 to 9, and in the high dose group for GD 9 to 12, and 6 to 15. An increasing trend in absolute maternal food consumption was noted on GD 18 to 20. Relative maternal food consumption was reduced in all treatment groups on GD 6 to 9, and in the high dose group for GD 9 to 12, and 6 to 15. A significant increase in maternal food consumption was observed on GD 15-18, GD 18 to 20, and GD 15 to 20 in the high dose group.
- Absolute (g/day) maternal water consumption was increased in the high dose group on GD 12 to 15, 15 to 18, 18 to 20, 6 to 15, and 15 to 20. An increasing trend in absolute maternal water consumption was noted on GD 6 to 9 and 9 to 12. Relative maternal water consumption was increased in the high dose group compared to the controls at all intervals from the beginning of dosing through the remainder of the study.

CLINICAL SIGNS
-Rooting behavior observed in all groups during dosing period indicating an aversion to dosing formula. Showed dose-related increase and earlier onset with increasing dose.

ORGAN WEIGHTS (Significant change if $p < 0.05$)
- Decreased gravis uterine weight in the high dose group
- Increased relative and adjusted maternal liver weight in the high dose group
- Kidney weight unaffected

FETAL DATA:
No Effects Seen:
- Corpora lutea per litter
- Implantations per litter
- % preimplantation loss per litter
- % late fetal deaths per litter
- % fetuses with visceral malformations per litter
- % fetuses with skeletal malformations per litter
- % fetuses with variations per litter
- % litters with variations

Significantly Increased at High Dose (Significant change if $p < 0.05$):
- % reabsorptions per litter
- % litters with reabsorptions
- % nonlive implants(reabsorptions and late fetal deaths) per litter
- % litters with nonlive implants
- % fetuses per litter with external malformations
- % male fetuses per litter with any malformations

Decreased at High Dose (Significant change if $p < 0.05$):
- Number of live fetuses per litter
- Avg. fetal body weight per litter: Females more affected than males, and

weighed less in both the mid and high dose groups compared to controls.
- Avg. fetal body weight for males only decreased in high dose group.

Source : National Toxicology Program, 1994.

Test condition : DOSES (25 dams per group)
0 mg/kg/day
20 mg/kg/day
35 mg/kg/day
50 mg/kg/day

EXPOSURE PERIOD: Gestation Day 6 through 15

FREQUENCY OF TREATMENT: daily

CONTROL GROUP AND TREATMENT: 25 pregnant females dosed with corn oil

NUMBER OF ANIMALS: 25 pregnant females per dose

VEHICLE: Corn Oil

CLINICAL OBSERVATIONS: observed daily for clinical signs of toxicity

MATING PROCEDURES
- Individual breeding pairs were cohabited overnight
- Morning with sperm found in vaginal lavage designated as GD 0

PARAMETERS ASSESSED
Maternal
- Body weight GD 0, 3, 6 through 15, 18, and 20
- Food and water GD 0, 3, 6, 9, 12, 15, 18, and 20
- Clinical signs of toxicity
- Organ weights (Gravid uterine, liver, kidney)
- Implant status, Uteri with no visible implant sites stained with ammonium sulfide to detect early absorptions.
Fetal
- Weight, sex, and morphological development.

STATISTICS:
- General Linear Models (GLM) procedures were applied for the analyses of variance (ANOVA) of maternal and fetal parameters (SAS Institute, 1989a; 1989b; 1990a; 1990b; 1990c). Prior to GLM-ANOVA analysis, an arcsine-square root transformation was performed on all litter-derived percentage data to normalize the means (Snedecor and Cochran, 1967) and Bartlett's test for homogeneity of variance was performed on all data to be analyzed by ANOVA (Winer, 1962). GLM-ANOVA analysis determined the significance of dose-response relationships and the significance of dose effects, replicate effects and dose x replicate interactions. When ANOVA revealed a significant dose effect ($p<0.05$), Dunnett's Test (Dunnett, 1955; 1964) and Williams' Test (Williams, 1971; 1972) were used to compare treated to control groups. One-tailed tests were used for all pair-wise comparisons except maternal food and water consumption, , fetal body weight, and percent male fetuses/litter.
- Nominal scale measures were analyzed by a Chi-Square Test for Independence and by the Cochran-Armitage Test for linear trend on proportional data (Agresti, 1990; Armitage, 1955; Cochran, 1954; SAS Institute, 1992). When a Chi-Square test showed significant experiment-wise differences, a one-tailed Fisher's exact probability test was used for pair-wise comparisons of treatment and control groups.

Test substance : Phenylmercaptan (Thiophenol) CAS Number 108-98-5, >99% pure.

Reliability	:	(1) valid without restriction
Flag	:	Critical study for SIDS endpoint
02.01.2004		(1) (2) (5) (8) (9) (18) (23) (24) (25) (26) (27) (28) (31) (34) (35) (37)
Species	:	rabbit
Sex	:	female
Strain	:	New Zealand white
Route of admin.	:	gavage
Exposure period	:	Gestational Day 6-19
Frequency of treatment	:	Daily
Duration of test	:	44 days (including 14 day quarantine period)
Doses	:	0, 10, 30, 40, 50 mg/kg/day (50 mg/kg/day dose in first replicate only, excluded from final study)
Control group	:	yes, concurrent vehicle
NOAEL Maternalt.	:	= 10 mg/kg bw
NOAEL Teratogen	:	>= 40 mg/kg bw
Method	:	OECD Guide-line 414 "Teratogenicity"
Year	:	1994
GLP	:	yes
Test substance	:	other TS

Result :

Results presented in the following format:
Dose in mg/kg/day / Target Concentration in mg/ml / Replicate 1 Concentration as % of target / Replicate 2 Concentration as % of target
0 / 0 / <DL / <DL
10 / 10 / 107 / 98
30 / 30 / 101 / 100
40 / 40 / * / 102
50 / 50 / 107 / **
DL-Detectable limit
* The 40 mg/kg/day dose was not included in the first replicate.
** 50 mg/kg group dropped from second replicate due to maternal toxicity. Replaced with 10 mg/kg group.

MATERNAL DATA:
- NOAEL: 10 mg/kg/day
- Toxic effects at 30 and 40 mg/kg/day were minor and transient so that the evidence of toxicity was equivocal.

FETAL DATA
- NOAEL: >/= 40 mg/kg/day
- LOAEL: could not be determined at the doses evaluated in this study
- 40 mg/kg/day did not adversely affect growth, viability, or morphological development of offspring.
- 50 mg/kg/day found to be excessively toxic, resulting in maternal mortality and morbidity.

MORTALITY: One doe in 10 mg/kg/day group died following dosing on GD 13, one doe in the 30 mg/kg/day group died following dosing on GD 6.

PREGNANCY RATE:
Control: 100%
10 mg/kg/day: 82%
30 mg/kg/day: 91%
40 mg/kg/day: 69%

Although pregnancy rate appeared to decline in the high dose group, all values fell within the historical control range for laboratory.

Number of Corpora Lutea/Doe, % Pre-implantation Loss, & Number of Implantations/Litter: comparable across all groups.

DURATION OF PREGNANCY: Pregnant does killed on GD 30

FOOD/WATER CONSUMPTION & BODY WEIGHT
- Food consumption marginally affected by treatment. In treated animals, relative food consumption was comparable to vehicle controls before dosing, but tended to be reduced during dosing. After dosing ended decreased food consumption was no longer evident.
- Decrease in food consumption translated into significant, albeit transient, reductions in maternal body weight gain on GD 12-15, the same period with the greatest reduction in food consumption.

ORGAN WEIGHTS: No adverse effects on maternal absolute or relative liver, right kidney, or gravis uterine weight.

FETAL DATA
Endpoints Examined, No Effects Seen:
- No. of reabsorptions/litter
- % late fetal deaths/litter
- % nonlive implants/litter
- No. live fetuses/litter, avg male and female body weight/litter
- Sex ratio
- External, visceral, or skeletal malformations

Effects Seen:
- Increase in the percent of females with variations per litter at 40 mg/kg/day for the study as a whole, or at 30 and 40 mg/kg/day for Replicate 2 alone.
- This increase in variations was mainly confined to the presence of extra or rudimentary lumbar ribs.

Source : National Toxicology Program, 1994.

Test condition : DOSES
10 mg/kg/day
20 mg/kg/day
30 mg/kg/day
40 mg/kg/day
50 mg/kg/day (first replicate only, excluded from final study)

EXPOSURE PERIOD: Gestational Day 6-19

FREQUENCY OF TREATMENT: Daily

TEST ANIMALS
- Age at Study Initiation: 5-6 months
- Number of Animals
-- Control: 24 does
-- 10, 20, 30, 50 mg/kg/day: 26 does
-- 40 mg/kg/day: 15 does

VEHICLE: corn oil

MATING PROCEDURES
- Injection of Pregnyl (chorionic gonadatropin, 0.1 ml/kg) prior to insemination.
- Females inseminated with undiluted ejaculate on day designated as Gestational Day (GD) 0.

PARAMETERS ASSESSED DURING STUDY:
Maternal:
- Clinical signs

- Food consumption
- Body weight on GD 0, 3, 6-19, 25, & 30
- Organ weights, liver, right kidney, intact uterus
- Ovarian corpora lutea
- Number of implant sites, uteri with no visible implantation sites stained with ammonium sulfide to detect early reabsorptions.

Fetal:
- Weight
- External morphological abnormalities
- Skeletal malformations

STATISTICS:
- General Linear Models (GLM) procedures were applied for the analyses of variance (ANOVA) of maternal and fetal parameters (SAS Institute, 1989a; 1989b; 1990a; 1990b; 1990c). Prior to GLM-ANOVA analysis, an arcsine-square root transformation was performed on all litter-derived percentage data to normalize the means (Snedecor and Cochran, 1967) and Bartlett's test for homogeneity of variance was performed on all data to be analyzed by ANOVA (Winer, 1962). GLM-ANOVA analysis determined the significance of dose-response relationships and the significance of dose effects, replicate effects and dose x replicate interactions. When ANOVA revealed a significant dose effect ($p<0.05$), Dunnett's Test (Dunnett, 1955; 1964) and Williams' Test (Williams, 1971; 1972) were used to compare treated to control groups. One-tailed tests were used for all pair-wise comparisons except maternal food consumption, maternal body and organ weights, maternal weight gains, fetal body weight, and percent male fetuses/litter.
- Nominal scale measures were analyzed by a Chi-Square Test for Independence and by the Cochran-Armitage Test for linear trend on proportional data (Agresti, 1990; Armitage, 1955; Cochran, 1954; SAS Institute, 1992). When a Chi-Square test showed significant experiment-wise differences, a one-tailed Fisher's exact probability test was used for pair-wise comparisons of treatment and control groups.

Test substance : Phenylmercaptan (Thiophenol) CAS Number 108-98-5, >99% pure.

Reliability : (1) valid without restriction
Flag : Critical study for SIDS endpoint
02.01.2004 (1) (2) (5) (8) (9) (19) (23) (24) (25) (26) (27) (28) (31) (34) (35) (37)

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7.1 END POINT SUMMARY

7.2 HAZARD SUMMARY

7.3 RISK ASSESSMENT